

Day :
 Wednesday
 Date:
 7/23/2003
 Time:
 20:05:47

PALM INTRANET

Inventor Name Search Result

Your Search was:

Last Name = FISCHER

First Name = ERNESTO

Application#	Patent#	Status	Date Filed	Title	Inventor Name
<u>60458005</u>	Not Issued	020	03/27/2003	INTEGRATED PROCESSING OF NATURAL GAS INTO LIQUID PRODUCTS	FISCHER-CALDERON, ERNESTO
<u>10051425</u>	Not Issued	030	01/18/2002	INTEGRATED PROCESSING OF NATURAL GAS INTO LIQUID PRODUCTS	FISCHER-CALDERON, ERNESTO
<u>10050922</u>	6564578	150	01/18/2002	SELF-REFRIGERATED LNG PROCESS	FISCHER-CALDERON, ERNESTO

Inventor Search Completed: No Records to Display.

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Inventor

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Day :
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PALM INTRANET

Inventor Name Search Result

Your Search was:

Last Name = BRISCOE

First Name = MICHAEL

Application#	Patent#	Status	Date Filed	Title	Inventor Name
<u>60458213</u>	Not Issued	020	03/27/2003	FUEL BLENDS COMPRISING LNG AND DIMETHYL ETHER AND METHODS FOR PREPARATION OF SAME	BRISCOE, MICHAEL D.
<u>60458005</u>	Not Issued	020	03/27/2003	INTEGRATED PROCESSING OF NATURAL GAS INTO LIQUID PRODUCTS	BRISCOE, MICHAEL D.
<u>60137642</u>	Not Issued	159	06/04/1999	ALTERNATING CONTRAST FILM/STICKER	BRISCOE , MICHAEL A
<u>29037544</u>	Not Issued	161	03/31/1995	BRUSH ATTACHMENT FOR A SAUCE BOTTLE	BRISCOE , MICHAEL A.
<u>10430734</u>	Not Issued	020	05/06/2003	LOADED TRANSDUCER FOR DOWNHOLE DRILLING COMPONENTS	BRISCOE, MICHAEL
<u>10427522</u>	Not Issued	019	04/30/2003	DATA TRANSMISSION SYSTEM FOR A DOWNHOLE COMPONENT	BRISCOE, MICHAEL
<u>10201339</u>	Not Issued	030	07/23/2002	HYDROGEN TO STEAM REFORMING OF NATURAL GAS TO SYNTHESIS GAS	BRISCOE, MICHAEL D.
<u>10051425</u>	Not Issued	030	01/18/2002	INTEGRATED PROCESSING OF NATURAL GAS INTO LIQUID PRODUCTS	BRISCOE, MICHAEL D.
<u>09408731</u>	Not Issued	161	09/29/1999	AUTOTHERMAL REACTOR AND A METHOD FOR CONVERTING A LIGHT HYDROCARBON STREAM INTO A SYNTHESIS GAS	BRISCOE , MICHAEL D.
<u>09405431</u>	<u>6156234</u>	150	09/23/1999	PROCESS FOR SUPPLYING A GASEOUS MIXTURE TO	BRISCOE , MICHAEL D.

				AN AUTOHERMAL REACTOR	
<u>09401604</u>	Not Issued	161	09/22/1999	HIGH PRESSURE AUTOHERMAL REACTOR AND A METHOD FOR PRODUCING SYNTHESIS GAS	BRISCOE , MICHAEL D.
<u>09401420</u>	<u>6239184</u>	150	09/22/1999	EXTENDED CATALYST LIFE FISCHER-TROPSCH PROCESS	BRISCOE, MICHAEL D.
<u>09397166</u>	<u>6344491</u>	150	09/16/1999	METHOD FOR OPERATING A FISCHER-TROPSCH PROCESS USING A HIGH PRESSURE AUTOHERMAL REACTOR AS THE PRESSURE SOURCE FOR THE PROCESS	BRISCOE , MICHAEL D.
<u>07321322</u>	<u>D321237</u>	150	03/10/1989	HOLLOW FISHING LURE	BRISCOE , MICHAEL A.

Inventor Search Completed: No Records to Display.

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Inventor

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WEST Search History

DATE: Wednesday, July 23, 2003

<u>Set Name</u>	<u>Query</u>	<u>Hit Count</u>	<u>Set Name</u>
side by side			result set
<i>DB=USPT,PGPB,JPAB,EPAB,DWPI; THES=ASSIGNEE; PLUR=YES; OP=ADJ</i>			
L18	L17 and isentropic\$4	23	L18
L17	L16 or l12	23	L17
L16	L15 and (methanol or dimethyl ether or Fischer tropsch)	8	L16
L15	L14 and gas near1 liquid	48	L15
L14	L13 and expan\$4	89	L14
L13	l9 and liqu\$7 near1 natural gas	89	L13
L12	L11 and gas near2 liquid	15	L12
L11	L10 and expan\$4	19	L11
L10	L9 and liquif\$5 natural gas	19	L10
L9	isentropic\$4	1455	L9
L8	L5 and liquif\$5 near2 neatural gas	0	L8
L7	L5 and liquif\$5 neatural gas	0	L7
L6	L5 and liquified neatural gas	0	L6
L5	L4 and natural gas	93	L5
L4	isentopic\$4 or isenthalpic\$4	405	L4
L3	L1 and expan\$4	1	L3
<i>DB=USPT,PGPB; THES=ASSIGNEE; PLUR=YES; OP=ADJ</i>			
L2	L1 and expan\$4	1	L2
L1	4445917.pn.	1	L1

END OF SEARCH HISTORY

Search Results - Record(s) 1 through 23 of 23 returned. 1. Document ID: US 20030101728 A1

L18: Entry 1 of 23

File: PGPB

Jun 5, 2003

PGPUB-DOCUMENT-NUMBER: 20030101728

PGPUB-FILING-TYPE: new

DOCUMENT-IDENTIFIER: US 20030101728 A1

TITLE: Cold heat reused air liquefaction/ vaporization and storage gas turbine electric power system

PUBLICATION-DATE: June 5, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Wakana, Harumi	Hitachi-shi		JP	
Chino, Koichi	Hitachi-shi		JP	
Yokomizo, Osamu	Naka-gun		JP	

APPL-NO: 10/ 183358 [PALM]

DATE FILED: June 28, 2002

RELATED-US-APPL-DATA:

Application 10/183358 is a continuation-in-part-of US application 09/765338, filed January 22, 2001, ABANDONED

FOREIGN-APPL-PRIORITY-DATA:

COUNTRY	APPL-NO	DOC-ID	APPL-DATE
JP	8-349301	1997JP-8-349301	December 27, 1997
JP	8-343061	1997JP-8-343061	December 24, 1997

INT-CL: [07] F02 C 7/143

US-CL-PUBLISHED: 60/727; 60/728

US-CL-CURRENT: 60/727; 60/728

REPRESENTATIVE-FIGURES: 1

ABSTRACT:

An energy storage gas-turbine electric power generating system includes a liquid air storage tank for storing liquid air, a vaporizing facility for vaporizing the liquid air stored in the liquid air storage tank, a combustor for generating a combusted gas by combusting the air vaporized by the vaporizing facility and a fuel, a gas turbine driven by the combusted gas generated in the combustor, and a gas-turbine generator connected to the gas turbine for generating electric power. The system further includes a pressurizing unit for pressurizing the liquid air stored in the liquid air storage tank up to a pressure higher than a pressure of air supplied to the combustor to supply the liquid air to the vaporizing facility, an expansion turbine driven by expanding the air vaporized by the vaporizing facility and an expansion-turbine generator connected to the expansion turbine for generating electric power.

[0001] This is a continuation-in-part (CIP) application of U.S. Ser. No. 09/765,338 filed Jan. 22, 2001, now pending, the entire disclosure of which is hereby incorporated by reference.

Full	Title	Citation	Front	Review	Classification	Date	Reference	Sequences	Attachments	Claims	KWIC
Draw Desc Image											

2. Document ID: US 20020151604 A1

L18: Entry 2 of 23

File: PGPB

Oct 17, 2002

PGPUB-DOCUMENT-NUMBER: 20020151604

PGPUB-FILING-TYPE: new

DOCUMENT-IDENTIFIER: US 20020151604 A1

TITLE: Hydrogen and elemental carbon production from natural gas and other hydrocarbons

PUBLICATION-DATE: October 17, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY	RULE-47
Detering, Brent A.	Idaho Falls	ID	US	
Kong, Peter C.	Idaho Falls	ID	US	

APPL-NO: 10/ 109427 [PALM]

DATE FILED: March 27, 2002

RELATED-US-APPL-DATA:

Application 10/109427 is a division-of US application 09/732451, filed December 6, 2000, US Patent No. 6395197

Application is a non-provisional-of-provisional application 60/172976, filed December 21, 1999,

INT-CL: [07] C07 C 27/06, B01 J 19/12

US-CL-PUBLISHED: 518/703; 422/186.29

US-CL-CURRENT: 518/703; 422/186.29

REPRESENTATIVE-FIGURES: 1

ABSTRACT:

Diatomeric hydrogen and unsaturated hydrocarbons are produced as reactor gases in a fast quench reactor. During the fast quench, the unsaturated hydrocarbons are further decomposed by reheating the reactor gases. More diatomic hydrogen is produced, along with elemental carbon. Other gas may be added at different stages in the process to form a desired end product and prevent back reactions. The product is a substantially clean-burning hydrogen fuel that leaves no greenhouse gas emissions, and elemental carbon that may be used in powder form as a commodity for several processes.

RELATED APPLICATION

[0001] This application is a divisional of pending application Ser. No. 09/732,451, filed Dec. 6, 2000, which claims priority from United States provisional application Serial No. 60/172,976, filed Dec. 21, 1999.

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NEWS 9 Mar 24 Additional information for trade-named substances without structures available in REGISTRY
NEWS 10 Apr 11 Display formats in DGENE enhanced
NEWS 11 Apr 14 MEDLINE Reload
NEWS 12 Apr 17 Polymer searching in REGISTRY enhanced
NEWS 13 Jun 13 Indexing from 1947 to 1956 added to records in CA/CAPLUS
NEWS 14 Apr 21 New current-awareness alert (SDI) frequency in WPIDS/WPINDEX/WPIX
NEWS 15 Apr 28 RDISCLOSURE now available on STN
NEWS 16 May 05 Pharmacokinetic information and systematic chemical names added to PHAR
NEWS 17 May 15 MEDLINE file segment of TOXCENTER reloaded
NEWS 18 May 15 Supporter information for ENCOMPPAT and ENCOMPLIT updated
NEWS 19 May 19 Simultaneous left and right truncation added to WSCA
NEWS 20 May 19 RAPRA enhanced with new search field, simultaneous left and right truncation
NEWS 21 Jun 06 Simultaneous left and right truncation added to CBNB
NEWS 22 Jun 06 PASCAL enhanced with additional data
NEWS 23 Jun 20 2003 edition of the FSTA Thesaurus is now available
NEWS 24 Jun 25 HSDB has been reloaded
NEWS 25 Jul 16 Data from 1960-1976 added to RDISCLOSURE
NEWS 26 Jul 21 Identification of STN records implemented
NEWS 27 Jul 21 Polymer class term count added to REGISTRY
NEWS 28 Jul 22 INPADOC: Basic index (/BI) enhanced; Simultaneous Left and Right Truncation available

NEWS EXPRESS April 4 CURRENT WINDOWS VERSION IS V6.01a, CURRENT MACINTOSH VERSION IS V6.0b(ENG) AND V6.0Jb(JP), AND CURRENT DISCOVER FILE IS DATED 01 APRIL 2003
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FILE COVERS 1907 - 23 Jul 2003 VOL 139 ISS 4
FILE LAST UPDATED: 22 Jul 2003 (20030722/ED)

This file contains CAS Registry Numbers for easy and accurate substance identification.

=> s liqu? (1a) natural gas
864377 LIQU?
857168 LIQ
81425 LIQS
888601 LIQ
(LIQ OR LIQS)
1382060 LIQU?
(LIQU? OR LIQ)
580235 NATURAL
28 NATURALS
580251 NATURAL
(NATURAL OR NATURALS)
1303512 GAS
445177 GASES
1466711 GAS
(GAS OR GASES)
60282 NATURAL GAS
(NATURAL(W) GAS)
L1 4002 LIQU? (1A) NATURAL GAS

=> s l1 and expan?
277125 EXPAN?
L2 376 L1 AND EXPAN?

=> s l2 and (isentropic? or isenthaptic?)
2500 ISENTROPIC?
0 ISENTHAPIC?

L3 13 L2 AND (ISENTROPIC? OR ISENTHALPIC?)

=> s 12 and (isentropic? or isenthalpic?)

2500 ISENTROPIC?

175 ISENTHALPIC?

L4 13 L2 AND (ISENTROPIC? OR ISENTHALPIC?)

=> s 14 and (GTL or gas (1a)liquid)

211 GTL

3 GTLS

213 GTL

(GTL OR GTLS)

1303512 GAS

445177 GASES

1466711 GAS

(GAS OR GASES)

630354 LIQUID

114069 LIQUIDS

718583 LIQUID

(LIQUID OR LIQUIDS)

857168 LIQ

81425 LIQS

888601 LIQ

(LIQ OR LIQS)

1249310 LIQUID

(LIQUID OR LIQ)

78848 GAS (1A)LIQUID

L5 2 L4 AND (GTL OR GAS (1A)LIQUID)

=> s 14 ibib ab 1-13

MISSING OPERATOR L4 IBIB

The search profile that was entered contains terms or nested terms that are not separated by a logical operator.

=> d 14 ibib ab 1-13

L4 ANSWER 1 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 2003:390719 CAPLUS

DOCUMENT NUMBER: 138:387864

TITLE: Self-refrigerated LNG process

INVENTOR(S): Fischer-Calderon, Ernesto

PATENT ASSIGNEE(S): BP Corporation North America Inc., USA

SOURCE: U.S., 10 pp.

CODEN: USXXAM

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|------------------------|------|----------|-----------------|----------|
| US 6564578 | B1 | 20030520 | US 2002-50922 | 20020118 |
| PRIORITY APPLN. INFO.: | | | US 2002-50922 | 20020118 |

AB The present invention is directed to a process for producing LNG by directing a feed stream comprising natural gas to a cooling stage that (a) cools the feed stream in at least one cooling step producing a cooled feed stream, (b) expands the cooled feed stream in at least one expansion step by reducing the pressure of the cooled feed stream producing a refrigerated vapor component and a liq. component, and (c) separates at least a portion of the refrigerated vapor component from the liq. component wherein at least a portion of the cooling for the process is derived from at least a portion of the refrigerated vapor component;

and repeating steps (a) through (c) one or more times until at least substantial portion of the feed stream in the 1st cooling stage is processed into LNG wherein the feed stream in step (a) comprises at least a portion of the liq. component produced from a previous cooling stage.

REFERENCE COUNT: 61 THERE ARE 61 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

L4 ANSWER 2 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN
ACCESSION NUMBER: 1999:388352 CAPLUS
DOCUMENT NUMBER: 131:21216
TITLE: **Natural gas liquefaction**
process and apparatus
INVENTOR(S): Dubar, Christopher Alfred Timothy
PATENT ASSIGNEE(S): BHP Petroleum Pty. Ltd., Australia
SOURCE: PCT Int. Appl., 24 pp.
CODEN: PIXXD2
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|--|------|----------|-----------------|-------------|
| WO 9930094 | A1 | 19990617 | WO 1998-GB3708 | 19981211 |
| W: AU, JP, US | | | | |
| RW: AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE | | | | |
| AU 9914977 | A1 | 19990628 | AU 1999-14977 | 19981211 |
| AU 752201 | B2 | 20020912 | | |
| EP 1038146 | A1 | 20000927 | EP 1998-959046 | 19981211 |
| R: DE, FR, GB | | | | |
| JP 2001526376 | T2 | 20011218 | JP 2000-524622 | 19981211 |
| US 6446465 | B1 | 20020910 | US 2001-951725 | 20010914 |
| PRIORITY APPLN. INFO.: | | | GB 1997-26297 | A 19971211 |
| | | | WO 1998-GB3708 | W 19981211 |
| | | | US 2000-581341 | A1 20000821 |

AB App. for **liquefying natural gas** comprises a series of heat exchangers for cooling the natural gas in countercurrent heat exchange relationship with a refrigerant, compression means for compressing the refrigerant, **expansion** means for **isentropically expanding** at least two sep. streams of the compressed refrigerant, the **expanded** streams of refrigerant communicating with a cool end of a resp. one of the heat exchangers, and a precooling refrigeration system for precooling the natural gas to a temp. <0.degree. before it is fed to the series of heat exchangers, and for precooling the compressed refrigerant discharged from a warm end of the series of heat exchangers to a temp. <0.degree. before it is fed back into the series of heat exchanges or to the **expansion** means.

REFERENCE COUNT: 4 THERE ARE 4 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

L4 ANSWER 3 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN
ACCESSION NUMBER: 1998:498159 CAPLUS
DOCUMENT NUMBER: 129:205073
TITLE: **Natural gas liquefaction**
method
INVENTOR(S): Yoshikawa, Yoshitsugu; Yamamoto, Osamu; Nakamura, Moritaka; Sugiyama, Shigeru; Fukuda, Seiji
PATENT ASSIGNEE(S): Chiyoda Chemical Engineering Construction Co., Japan
SOURCE: Jpn. Kokai Tokkyo Koho, 8 pp.
CODEN: JKXXAF
DOCUMENT TYPE: Patent

LANGUAGE: Japanese

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|------------------------|------|----------|-----------------|----------|
| JP 10204455 | A2 | 19980804 | JP 1997-12670 | 19970127 |
| US 6062041 | A | 20000516 | US 1997-974824 | 19971120 |
| PRIORITY APPLN. INFO.: | | | JP 1997-12670 | 19970127 |

AB The method comprises liquefying natural gas feed and recycle gas by utilizing a single-component refrigerant or a mixed refrigerant in a high temp. state, and with a substantially isentropic expansion in a low temp. stage, pressurizing the non-liquefied part of the recycle gas in a compressor, recycling the nonliquefied part of the feed natural gas, and then recovering the liquefied part by the refrigerant exchanging heat with the non-liquefied part stream produced from the substantially isentropic expansion, in a plate-fin heat exchanger or the like. The mixed refrigerant may contain CH₄, C₂H₅, C₃H₈, C₃H₆ and C₄H₈.

L4 ANSWER 4 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1997:536516 CAPLUS

DOCUMENT NUMBER: 127:192714

TITLE: Increasing liquid hydrocarbon recovery from natural gas: evaluation of the vortex-tube device

AUTHOR(S): Hajdik, Brock; Erdol, Jurgen Steinle - Beb; Lorey, Manfred; Thomas, Keith

CORPORATE SOURCE: CBS Engineering, Houston, TX, USA

SOURCE: Proceedings, Annual Convention - Gas Processors Association (1997), 76th, 219-226

CODEN: PGPAAC; ISSN: 0096-8870

PUBLISHER: Gas Processors Association

DOCUMENT TYPE: Journal

LANGUAGE: English

AB The vortex-tube device provides a useful addn. to the range of equipment available to the gas industry. The use of vortex-tube equipment permits improved sepn. in comparison with a Joule-Thomson system, without entering into the cost and complexity of a true isentropic system such as a turbo-expander unit. The comparative advantage of the vortex tube depends upon the inlet conditions of the gas and the pressure drop that is available. An optimum pressure drop of 25 - 35 % of the inlet gas pressure has been confirmed in practice. Although not yet tested on operating plant, it is expected that a loss of performance of vortex-tube units will occur for inlet liq.-to-gas ratios of greater than 20%. Units with up to 5% liq. at the inlet have been successfully operated showing that a single phase gas at the unit inlet is not essential. It is expected that future application of vortex tube units will be concd. where performance improvements over Joule-Thomson units, at low capital cost, are required.

L4 ANSWER 5 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1997:467217 CAPLUS

DOCUMENT NUMBER: 127:111022

TITLE: Power recovery through thermodynamic expansion of liquid methane

AUTHOR(S): Cengel, Yunus A.; Kimmel, Hans

CORPORATE SOURCE: Department of Mechanical Engineering, University of Nevada, Reno, Reno, NV, USA

SOURCE: Proceedings of the American Power Conference (1997), 59(1), 271-276

CODEN: PAPWA2; ISSN: 0097-2126

PUBLISHER: American Power Conference

DOCUMENT TYPE: Journal
LANGUAGE: English

AB Thermodn. aspects of a cryogenic turbine-generator assembly that admits methane at a high pressure and discharges it at a low pressure are investigated. The entire turbine-generator assembly is submerged in methane. The study is intended to quantify the effect of the turbine generator assembly on the exit temp. of methane, the rate of heat transfer to methane, the rate of internal heat generation due to the hydraulic inefficiency of the turbine and the heat given off by generator, and the resulting temp. rise of methane, the amt. of elec. power generated and potential revenues from it. The submerged turbine-generator assembly appears to be very attractive both thermodynamically and economically. The unit will put the power generation potential of the liq. methane into best use while actually lowering the temp. of liq. methane. The exit temp. of liq. methane as it **expands** from 113.0 K and 4.479 MPa to 0.517 MPa will range from 112.0 K in the case of an **isentropic** turbine, to 114.6 K in the case of an **expansion** valve. In the case of 75% efficient submerged turbine-generator assembly, the exit temp. will be 112.6 K. Therefore, the temp. of methane will rise by 1.6 K in the **expansion** valve, but it will drop by 0.4 K in the turbine-generator assembly, making this system very desirable in cryogenic applications. Heat transfer to the container of the turbine generator assembly appears to be very small, and the temp. rise of methane due to this heat gain is negligible (under 0.007 K). The system investigated has a power generation potential of 1085 kW, but because of the inefficiencies in the turbine and the generator, it is realistic to expect to generate about 814 kW of elec. power. The turbine-generator assembly will save the facility about half a million dollars a year in electricity costs if the facility operates continuously.

L4 ANSWER 6 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1997:358930 CAPLUS

DOCUMENT NUMBER: 126:332449

TITLE: Liquefaction apparatus for natural gas using heat exchangers on a ship

INVENTOR(S): Dubar, Christopher Alfred Timot; Leh Ming Tu, Oliver

PATENT ASSIGNEE(S): Bhp Petroleum Pty. Ltd., Australia; Dubar, Christopher Alfred Timothy; Leh Ming Tu, Oliver

SOURCE: PCT Int. Appl., 58 pp.

CODEN: PIXXD2

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 2

PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|---------------|--|----------|-----------------|----------|
| WO 9713108 | A1 | 19970410 | WO 1996-GB2434 | 19961004 |
| W: | AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM | | | |
| RW: | KE, LS, MW, SD, SZ, UG, AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, BF, BJ, CF, CG | | | |
| AU 9671396 | A1 | 19970428 | AU 1996-71396 | 19961004 |
| EP 857285 | A1 | 19980812 | EP 1996-932719 | 19961004 |
| EP 857285 | B1 | 20030423 | | |
| R: | AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, FI | | | |
| RU 2141084 | C1 | 19991110 | RU 1998-108464 | 19961004 |
| JP 2000513757 | T2 | 20001017 | JP 1997-514076 | 19961004 |

| | | | | |
|------------------------|----|----------|----------------|------------|
| AT 238529 | E | 20030515 | AT 1996-932719 | 19961004 |
| NO 9801514 | A | 19980603 | NO 1998-1514 | 19980403 |
| AU 754108 | B2 | 20021107 | AU 2000-42610 | 20000622 |
| PRIORITY APPLN. INFO.: | | | GB 1995-20303 | A 19951005 |
| | | | GB 1995-20348 | A 19951005 |
| | | | GB 1995-20349 | A 19951005 |
| | | | GB 1995-20356 | A 19951005 |
| | | | WO 1996-GB2434 | W 19961004 |

AB An offshore app. for **liquefying natural gas** comprises a support structure which is either floatable or is otherwise adapted to be disposed in an offshore location at least partially above sea level, and **natural gas liquefaction** means disposed on or in the support structures. The **natural gas liquefaction** means comprises a series of heat exchangers for cooling the natural gas in countercurrent heat exchange relation with a refrigerant, compression means for compressing the refrigerant, and **expansion** means for **isentropically expanding** at least two sep. streams of the compressed refrigerant, wherein said **expanded** streams of refrigerant communicate with a cool end of a resp. one of the heat exchangers.

L4 ANSWER 7 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN
 ACCESSION NUMBER: 1997:342436 CAPLUS
 DOCUMENT NUMBER: 126:319308
 TITLE: Liquefaction process
 INVENTOR(S): Dubar, Christopher Alfred Timot
 PATENT ASSIGNEE(S): Bhp Petroleum Pty. Ltd., Australia; Dubar, Christopher Alfred Timothy
 SOURCE: PCT Int. Appl., 57 pp.
 CODEN: PIXXD2
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 2
 PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|---|------|----------|-----------------|------------|
| WO 9713109 | A1 | 19970410 | WO 1996-GB2443 | 19961004 |
| W: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, AM, AZ, BY, KG, KZ, MD, RU, TJ, TM | | | | |
| RW: KE, LS, MW, SD, SZ, UG, AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, BF, BJ, CF, CG | | | | |
| AU 9671401 | A1 | 19970428 | AU 1996-71401 | 19961004 |
| AU 718068 | B2 | 20000406 | | |
| EP 862717 | A1 | 19980909 | EP 1996-932725 | 19961004 |
| EP 862717 | B1 | 20030312 | | |
| R: AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LI, LU, NL, SE, MC, PT, IE, FI | | | | |
| RU 2141611 | C1 | 19991120 | RU 1998-108463 | 19961004 |
| JP 2000506591 | T2 | 20000530 | JP 1997-514081 | 19961004 |
| AT 234450 | E | 20030315 | AT 1996-932725 | 19961004 |
| NO 9801515 | A | 19980603 | NO 1998-1515 | 19980403 |
| US 5916260 | A | 19990629 | US 1998-51221 | 19980713 |
| AU 754108 | B2 | 20021107 | AU 2000-42610 | 20000622 |
| PRIORITY APPLN. INFO.: | | | GB 1995-20303 | A 19951005 |
| | | | GB 1995-20348 | A 19951005 |
| | | | GB 1995-20349 | A 19951005 |
| | | | GB 1995-20356 | A 19951005 |
| | | | WO 1996-GB2443 | W 19961004 |

AB A natural gas liquefaction process comprises passing natural gas through a series of heat exchangers in countercurrent relationship with a gaseous refrigerant circulated through work expansion cycle. The work expansion cycle comprises compressing the refrigerant, dividing and cooling the refrigerant to produce at least first and second cooled refrigerant streams, substantially isentropically expanding the first refrigerant stream to a coolest refrigerant temp., substantially isentropically expanding the second refrigerant stream to an intermediate refrigerant temp. warmer than the coolest refrigerant temp., and delivering the refrigerant in the first and second refrigerant streams to a resp. heat exchanger for cooling the natural gas thorough corresponding temp. ranges. The refrigerant in the first stream is isentropically expanded to a pressure at least 10 times greater than the total pressure drop of the first refrigerant stream across the series of heat exchangers, the pressure being in the range of 1.2-2.5 MPa.

L4 ANSWER 8 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1994:439057 CAPLUS
DOCUMENT NUMBER: 121:39057
TITLE: Method for liquefying natural gas.
INVENTOR(S): Kikkawa, Yoshitsugi; Yamamoto, Osamu; Sakaguchi, Junichi; Nakamura, Moritaka
PATENT ASSIGNEE(S): Chiyoda Corp., Japan
SOURCE: Eur. Pat. Appl., 21 pp.
CODEN: EPXXDW
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|-----------------------|------|----------|-----------------|----------|
| EP 599443 | A1 | 19940601 | EP 1993-301750 | 19930308 |
| EP 599443 | B1 | 19970917 | | |
| R: DE, FR, GB, IT, NL | | | | |
| JP 06159928 | A2 | 19940607 | JP 1992-335540 | 19921120 |
| CA 2090809 | AA | 19940521 | CA 1993-2090809 | 19930302 |
| CA 2090809 | C | 19970408 | | |
| US 5363655 | A | 19941115 | US 1993-28025 | 19930308 |

PRIORITY APPLN. INFO.: JP 1992-335540 19921120

AB The method for liquefying natural gas can be readily adapted to LNG plants of all sizes without requiring expensive and special heat exchangers. The liquefaction of feed gas of natural gas and recycle natural gas is carried out with a single-component refrigerant or a mixed refrigerant in a high temp. state, and with a substantially isentropic expansion in a low temp. stage, and a non-liquefied part of the recycle gas after the expansion step is pressurized with a compressor and recycled along with a recycle stream of nonliquefied par of the feed natural gas, the liquefied part by the refrigerant exchanging heat with the non-liquefied part stream produced from the substantially isentropic expansion, in a plate-fin heat exchanger or the like. The compressor is driven by the power obtained by the substantially isentropic expansion.

L4 ANSWER 9 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1989:557278 CAPLUS
DOCUMENT NUMBER: 111:157278
TITLE: Reliquefaction of boil-off from liquefied

INVENTOR(S): **natural gas**
 Cook, Philip J.
 PATENT ASSIGNEE(S): Air Products and Chemicals, Inc., USA
 SOURCE: U.S., 9 pp.
 CODEN: USXXAM
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 1
 PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|---------------------------|------|----------|-----------------|----------|
| US 4846862 | A | 19890711 | US 1988-241158 | 19880906 |
| EP 358100 | A2 | 19900314 | EP 1989-116028 | 19890830 |
| EP 358100 | A3 | 19900718 | | |
| EP 358100 | B1 | 19940119 | | |
| R: BE, DE, ES, FR, GB, NL | | | | |
| JP 02106688 | A2 | 19900418 | JP 1989-227308 | 19890901 |
| CN 1041034 | A | 19900404 | CN 1989-106910 | 19890906 |
| CN 1016267 | B | 19920415 | | |

PRIORITY APPLN. INFO.: US 1988-241158 19880906
 AB In a process for the reliquefaction of boil-off gas contg. <10% N2 resulting from the evapn. of **liquefied natural gas** (LNG) contained in a storage vessel, a closed-loop refrigeration cycle is utilized where an **isenthalpically expanded** stream is warmed against an initially cooled boil-off stream. The boil-off LNG stream is initially cooled by indirect heat exchange with an **isentropically expanded** refrigerant stream.

L4 ANSWER 10 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN
 ACCESSION NUMBER: 1984:425901 CAPLUS
 DOCUMENT NUMBER: 101:25901
 TITLE: Liquefying methane
 INVENTOR(S): Newton, Charles Leo
 PATENT ASSIGNEE(S): Air Products and Chemicals, Inc., USA
 SOURCE: Eur. Pat. Appl., 39 pp.
 CODEN: EPXXDW
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 1
 PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|-------------------------------|------|----------|-----------------|----------|
| EP 102087 | A2 | 19840307 | EP 1983-108546 | 19830830 |
| EP 102087 | A3 | 19850116 | | |
| EP 102087 | B1 | 19861230 | | |
| R: BE, DE, FR, GB, IT, NL, SE | | | | |
| US 4445916 | A | 19840501 | US 1982-412686 | 19820830 |
| CA 1200191 | A1 | 19860204 | CA 1983-435183 | 19830823 |
| NO 8303100 | A | 19840301 | NO 1983-3100 | 19830829 |
| NO 160600 | B | 19890123 | | |
| NO 160600 | C | 19890503 | | |
| ES 525205 | A1 | 19850901 | ES 1983-525205 | 19830829 |
| JP 59081483 | A2 | 19840511 | JP 1983-158934 | 19830830 |
| JP 04009987 | B4 | 19920221 | | |
| AU 8318692 | A1 | 19840308 | AU 1983-18692 | 19830905 |
| AU 553598 | B2 | 19860724 | | |

PRIORITY APPLN. INFO.: US 1982-412686 19820830
 AB A process for **liquefying natural gas** is disclosed in which heavier hydrocarbons are sep'd. in a scrub column from

the natural gas prior to liquefaction. The feed to the scrub column is intercooled against the CH₄-rich overhead from the column and **isentropically expanded** before introduction to the column, and sepd. from the heavier hydrocarbons. The CH₄-rich overheads is compressed utilizing the mech. energy of **expansion** and liquefied in a refrigerated heat exchanger.

L4 ANSWER 11 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1979:525899 CAPLUS

DOCUMENT NUMBER: 91:125899

TITLE: Nitrogen-methane separation process and system

INVENTOR(S): Yearout, James D.

PATENT ASSIGNEE(S): USA

SOURCE: U.S., 12 pp.

CODEN: USXXAM

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|------------|------|----------|-----------------|----------|
| US 4158556 | A | 19790619 | US 1977-786130 | 19770411 |

PRIORITY APPLN. INFO.: US 1977-786130 19770411

AB Pipeline-quality natural gas contg. .1toreq.7% N is produced from natural gas mixts. contg. .apprx.15-80% N by a low-temp. distn. process in which the mixt. is charged at a pressure significantly below the crit. pressure for the mixt. (i.e., <700 psia), and nonadiabatic or differential distn. is used to provide max. thermodn. efficiency. The raw feedstock is subjected to regenerative heat exchange (e.g., with cold waste N) to cool it to near its satn. point, and the cooled feed is charged to a fractionation column operating at substantially the same pressure. The mixt. is sepd. in the column; and the N withdrawn overhead is cooled by being work-**expanded**, recycled to provide refrigeration for the column, and used to cool the feed in a heat exchanger. The **liquefied natural gas** is withdrawn from the lower part of the column and partly flashed to reduce its temp. prior to evapn. in the case of a gas-producing plant or prior to **isentropic expansion** to liq. storage in the case of a liq.-producing plant. Prior to the distn. process, CO₂ can be removed from the raw feed gas by the use of refrigerated MeOH [67-56-1] as an absorbent.

L4 ANSWER 12 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN

ACCESSION NUMBER: 1978:139091 CAPLUS

DOCUMENT NUMBER: 88:139091

TITLE: Liquefied methane

INVENTOR(S): Newton, Charles L.; Gaumer, Lee S.

PATENT ASSIGNEE(S): Air Products and Chemicals, Inc., USA

SOURCE: U.S., 6 pp.

CODEN: USXXAM

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

| PATENT NO. | KIND | DATE | APPLICATION NO. | DATE |
|-------------|------|----------|-----------------|----------|
| US 4065278 | A | 19771227 | US 1976-673162 | 19760402 |
| JP 61016908 | B4 | 19860502 | JP 1977-139788 | 19771121 |
| JP 54072203 | A2 | 19790609 | | |

PRIORITY APPLN. INFO.: US 1976-673162 19760402

AB A process is disclosed for producing **liquefied natural**

gas from a feedstock contg. 60-90 mol % CH₄ [74-82-8]. Thus, the feedstock at .gtoreq.860 psia is cooled to .apprx.70.degree.F and **isentropically expanded** to 480 psia, which cools the feed to .apprx.-72.degree.F.. The product is fractionated at 200-650 psia to form an overhead rich in CH₄ and a bottoms fraction. The overhead is compressed utilizing energy obtained from the **expansion** and then liquefied in a refrigeration cycle.

L4 ANSWER 13 OF 13 CAPLUS COPYRIGHT 2003 ACS on STN
ACCESSION NUMBER: 1975:46083 CAPLUS
DOCUMENT NUMBER: 82:46083
TITLE: Liquefaction of gases using multistage **isentropic expansion** in the region of moist vapor
AUTHOR(S): Bochaver, K. Z.; Brodetskaya, D. Z.; Ivanova, V. I.; Startsev, A. A.
CORPORATE SOURCE: USSR
SOURCE: Neftepererabotka i Neftekhimiya (Vsesoyuznoe Ob'edinenie Neftekhim) (1972), 1, 281-8
CODEN: NPNKA5
DOCUMENT TYPE: Journal
LANGUAGE: Russian
AB A method of **expansion** of gases, in the region of moist vapor, was investigated, which enabled the moisture content of vapor to be reduced in the circulating part of a compressed air driven turbine-compressor, and thereby increased the efficiency of **expansion** in the turbine. Calcns. and plans were made for a turbine, driven by compressed gas, with centripetal and axial stages, and a multistage axial part. The variant recommended, secured an efficiency of compression, by **expansion** of 0.715. The machine had increased stability to corrosion due to low moisture content at each stage, through intermediate sepn.; less peripheral speed; feed of vapor formed by throttling liq. in discharge separator to discharge at the edge of the nozzle.

3. Document ID: US 6412302 B1

L18: Entry 3 of 23

File: USPT

Jul 2, 2002

US-PAT-NO: 6412302
DOCUMENT-IDENTIFIER: US 6412302 B1

TITLE: LNG production using dual independent expander refrigeration cycles

DATE-ISSUED: July 2, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---------------------|---------------|-------|----------|---------|
| Foglietta, Jorge H. | Missouri City | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE | CODE |
|--|---------|-------|----------|---------|------|------|
| ABB Lummus Global, Inc. - Randall Division | Houston | TX | | | 02 | |

APPL-NO: 09/ 828551 [PALM]

DATE FILED: April 6, 2001

PARENT-CASE:

This application claims the benefits of provisional patent application, U.S. Ser. No. 60/273,531, filed on Mar. 6, 2001.

INT-CL: [07] F25 J 1/00, F25 J 3/00

US-CL-ISSUED: 62/611; 62/619

US-CL-CURRENT: 62/611; 62/619

FIELD-OF-SEARCH: 62/611, 62/612, 62/613, 62/614, 62/619, 62/912, 62/606

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|-------------------|--------|
| <u>4057972</u> | November 1977 | Sarsten | 62/612 |
| <u>4461634</u> | July 1984 | Duckett et al. | 62/611 |
| <u>4755200</u> | July 1988 | Liu et al. | 62/612 |
| <u>4911741</u> | March 1990 | Davis et al. | 62/613 |
| <u>5036671</u> | August 1991 | Nelson et al. | 62/612 |
| <u>5651269</u> | July 1997 | Prevost et al. | 62/613 |
| <u>5755114</u> | May 1998 | Foglietta | 62/618 |
| <u>6041619</u> | March 2000 | Fischer et al. | 62/612 |
| <u>6105389</u> | August 2000 | Paradowski et al. | 62/613 |

ART-UNIT: 3744

PRIMARY-EXAMINER: Doerrler, William C.

ABSTRACT:

A process for producing a liquified natural gas stream that includes cooling at least a portion of a pressurized natural gas feed stream by heat exchange contact with first and second expanded refrigerants that are used in independent refrigeration cycles. The first expanded refrigerant is selected from methane, ethane and treated and pressurized natural gas. The second expanded refrigerant is nitrogen.

21 Claims, 4 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KOMC |
|-----------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| Draw Desc | | Image | | | | | | | | |

4. Document ID: US 6395197 B1

L18: Entry 4 of 23

File: USPT

May 28, 2002

US-PAT-NO: 6395197

DOCUMENT-IDENTIFIER: US 6395197 B1

TITLE: Hydrogen and elemental carbon production from natural gas and other hydrocarbons

DATE-ISSUED: May 28, 2002

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|-------------|-------|----------|---------|
| Detering; Brent A. | Idaho Falls | ID | | |
| Kong; Peter C. | Idaho Falls | ID | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|------------------------|-------------|-------|----------|---------|-----------|
| Bechtel BWXT Idaho LLC | Idaho Falls | ID | | | 02 |

APPL-NO: 09/ 732451 [PALM]

DATE FILED: December 6, 2000

PARENT-CASE:

RELATED APPLICATION This application claims priority from United States provisional application Ser. No. 60/172,976 filed on Dec. 21, 1999 and is incorporated by reference.

INT-CL: [07] C07 C 1/02, C01 B 31/18, C01 B 31/00, C01 B 3/02, C01 B 3/24

US-CL-ISSUED: 252/373; 423/418.2, 423/445R, 423/648.1, 423/650

US-CL-CURRENT: 252/373; 423/418.2, 423/445R, 423/648.1, 423/650

FIELD-OF-SEARCH: 252/373, 423/418.2, 423/445R, 423/648.1, 423/650

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|-------------------|------------|
| <u>5409784</u> | April 1995 | Bromberg et al. | 429/13 |
| <u>5425332</u> | June 1995 | Rabinovich et al. | 123/3 |
| <u>5437250</u> | August 1995 | Rabinovich et al. | 219/121.48 |
| <u>5481080</u> | January 1996 | Lynum et al. | |
| <u>5500501</u> | March 1996 | Lynum et al. | 219/212.48 |
| <u>5527518</u> | June 1996 | Lynum et al. | 423/449.1 |
| <u>5725616</u> | March 1998 | Lynum et al. | 48/127.3 |
| <u>5749937</u> | May 1998 | Detering et al. | 75/10.19 |
| <u>5852927</u> | December 1998 | Cohn et al. | 60/39.05 |
| <u>5887554</u> | March 1999 | Cohn et al. | 123/3 |

FOREIGN PATENT DOCUMENTS

| FOREIGN-PAT-NO | PUBN-DATE | COUNTRY | US-CL |
|----------------|----------------|---------|-------|
| 0 618 951 | September 1996 | EP | |
| PCT/NO92/00200 | January 1992 | WO | |

ART-UNIT: 1621

PRIMARY-EXAMINER: Richter; Johann

ASSISTANT-EXAMINER: Parsa; J.

ATTY-AGENT-FIRM: Workman Nydegger & Seeley

ABSTRACT:

Diatomeric hydrogen and unsaturated hydrocarbons are produced as reactor gases in a fast quench reactor. During the fast quench, the unsaturated hydrocarbons are further decomposed by reheating the reactor gases. More diatomic hydrogen is produced, along with elemental carbon. Other gas may be added at different stages in the process to form a desired end product and prevent back reactions. The product is a substantially clean-burning hydrogen fuel that leaves no greenhouse gas emissions, and elemental carbon that may be used in powder form as a commodity for several processes.

27 Claims, 12 Drawing figures

| | | | | | | | | | |
|---------------------------|-----------------------|--------------------------|-----------------------|------------------------|--------------------------------|----------------------|---------------------------|---------------------------|-----------------------------|
| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments |
| Draw Desc | Image | | | | | | | | |

KMC

5. Document ID: US 6082133 A

L18: Entry 5 of 23

File: USPT

Jul 4, 2000

US-PAT-NO: 6082133

DOCUMENT-IDENTIFIER: US 6082133 A

TITLE: Apparatus and method for purifying natural gas via cryogenic separation

DATE-ISSUED: July 4, 2000

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---------------------|----------|-------|----------|---------|
| Barclay; Michael A. | Redmond | WA | | |
| Brook; Thomas C. | Victoria | | | CA |
| Barclay; John A. | Redmond | WA | | |
| Tison; Raymond R. | Mentor | OH | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|------------------------|---------|-------|----------|---------|-----------|
| Cryo Fuel Systems, Inc | Redmond | WA | | | 02 |

APPL-NO: 09/ 245570 [PALM]
 DATE FILED: February 5, 1999

INT-CL: [07] F25 I 1/00

US-CL-ISSUED: 62/619, 62/637, 62/909
 US-CL-CURRENT: 62/619, 62/637, 62/909

FIELD-OF-SEARCH: 62/619, 62/637, 62/908, 62/909

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|-------------|-----------------|--------|
| <u>3093470</u> | June 1963 | Melikian et al. | 62/637 |
| <u>4283212</u> | August 1981 | Graham et al. | 62/908 |
| <u>5737941</u> | April 1998 | Hsiung et al. | 62/908 |
| <u>5740682</u> | April 1998 | Lavie | 62/908 |

ART-UNIT: 374

PRIMARY-EXAMINER: Capossela; Ronald

ATTY-AGENT-FIRM: Ward; Calvin B.

ABSTRACT:

An apparatus for separating CO₂ from a mixture of gases includes CO₂ and a second gas, the apparatus includes an active heat exchanger and a regenerating heat exchanger. The active heat exchanger includes a heat exchange surface in contact with the mixture of gases. The mixture of gases is present in the active heat exchanger at a predetermined pressure which is chosen such that CO₂ freezes on the heat exchange surface when the surface is cooled by a refrigerant having a temperature below that at which CO₂ freezes at the predetermined pressure. The regenerating heat exchanger includes a heat exchange surface in contact with the refrigerant and also in contact with a layer of frozen CO₂. The refrigerant enters the regenerating heat exchanger at a temperature above that at which the CO₂ in the frozen layer of CO₂ sublimates. The sublimation of the solid CO₂ cools the refrigerant prior to the refrigerant being expanded through an expansion valve, which reduces the temperature of the refrigerant to a point below the freezing point of CO₂ at the predetermined pressure. The refrigerant is re-compressed by a compressor after leaving the active heat exchanger. In the preferred embodiment of the present invention, the gaseous CO₂ released by the regenerating heat exchanger is used to precool the incoming gas mixture. A second precooling heat exchanger precools the compressed refrigerant by providing thermal contact with the refrigerant leaving the active heat exchanger.

5 Claims, 3 Drawing figures

6. Document ID: US 5651269 A

L18: Entry 6 of 23

File: USPT

Jul 29, 1997

US-PAT-NO: 5651269

DOCUMENT-IDENTIFIER: US 5651269 A

TITLE: Method and apparatus for liquefaction of a natural gas

DATE-ISSUED: July 29, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------|--------------------------|-------|----------|---------|
| Prevost; Isabelle | Conflans Sainte Honorine | | | FR |
| Rojey; Alexandre | Rueil Malmaison | | | FR |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE ZIP CODE | COUNTRY | TYPE CODE |
|------------------------------|-----------------|----------------|---------|-----------|
| Institut Francais du Petrole | Rueil Malmaison | | FR | 03 |

APPL-NO: 08/ 507277 [PALM]

DATE FILED: August 30, 1995

FOREIGN-APPL-PRIORITY-DATA:

| COUNTRY | APPL-NO | APPL-DATE |
|---------|----------|-------------------|
| FR | 93 15924 | December 30, 1993 |
| FR | 94 02024 | February 21, 1994 |

PCT-DATA:

| APPL-NO | DATE-FILED | PUB-NO | PUB-DATE | 371-DATE | 102(E)-DATE |
|----------------|-------------------|------------|-------------|--------------|--------------|
| PCT/FR94/01535 | December 26, 1994 | WO95/18345 | Jul 6, 1995 | Aug 30, 1995 | Aug 30, 1995 |

INT-CL: [06] E25 I 3/00

US-CL-ISSUED: 62/613

US-CL-CURRENT: 62/613

FIELD-OF-SEARCH: 62/613

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|--------|
| <u>2903858</u> | September 1959 | Bocquet | 62/613 |

ART-UNIT: 344

PRIMARY-EXAMINER: Capossela; Ronald C.

ATTY-AGENT-FIRM: Antonelli, Terry, Stout & Kraus, LLP

ABSTRACT:

The method of the invention for liquefying a natural gas consists in liquefying at least a part of this gas by expanding it with mechanical energy, whereby during this expansion the gas changes from a dense phase to a liquid phase without undergoing a phase transition.

24 Claims, 8 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KINIC |
|------------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|-------|
| Drawn Desc | Image | | | | | | | | | |

7. Document ID: US 5615561 A

L18: Entry 7 of 23

File: USPT

Apr 1, 1997

US-PAT-NO: 5615561

DOCUMENT-IDENTIFIER: US 5615561 A

TITLE: LNG production in cryogenic natural gas processing plants

DATE-ISSUED: April 1, 1997

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|------------------------|----------------|-------|----------|---------|
| Houshmand; Mory | Salt Lake City | UT | | |
| Kruger; Kimberly A. | Salt Lake City | UT | | |
| Alves; Gerald W. | Sugar Land | TX | | |
| Ostaszewski; Ricardo | Sugar Land | TX | | |
| Belhateche; Noureddine | Katy | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE | CODE |
|---------------------------------|----------------|-------|----------|---------|------|------|
| Williams Field Services Company | Salt Lake City | UT | | | | 02 |

APPL-NO: 08/ 335902 [PALM]

DATE FILED: November 8, 1994

INT-CL: [06] F25 I 1/00

US-CL-ISSUED: 62/611; 62/620

US-CL-CURRENT: 62/611; 62/620

FIELD-OF-SEARCH: 62/9, 62/11, 62/13, 62/23, 62/42, 62/24, 62/620, 62/611

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|-------------------|---------|
| <u>3195316</u> | July 1965 | Maher et al. | 62/52 |
| <u>3299646</u> | January 1967 | Stuart et al. | 62/40 |
| <u>3724226</u> | April 1973 | Pachaly | 62/39 |
| <u>3735600</u> | May 1973 | Dowdell et al. | 62/39 |
| <u>4033735</u> | July 1977 | Swenson | 62/9 |
| <u>4274849</u> | June 1981 | Garier et al. | 62/9 |
| <u>4339253</u> | July 1982 | Caetani et al. | 62/40 |
| <u>4456459</u> | June 1984 | Brundige, Jr. | 62/9 |
| <u>4539028</u> | September 1985 | Paradowski et al. | 62/9 |
| <u>4566885</u> | January 1986 | Haak | 62/9 |
| <u>4680041</u> | July 1987 | DeLong | 62/23 X |
| <u>4687499</u> | August 1987 | Aghili | 62/42 X |
| <u>4711651</u> | December 1987 | Sharma et al. | 62/23 X |
| <u>4746342</u> | May 1988 | DeLong et al. | 62/24 |
| <u>4805413</u> | February 1989 | Mitchell et al. | 62/42 X |
| <u>5036671</u> | August 1991 | Nelson et al. | 62/23 |
| <u>5089034</u> | February 1992 | Markovs et al. | 55/28 |
| <u>5275005</u> | January 1994 | Campbell et al. | 62/24 |
| <u>5359856</u> | November 1994 | Rhoades et al. | 62/9 |
| <u>5363655</u> | November 1994 | Kikkawa et al. | 62/9 |
| <u>5402645</u> | April 1995 | Johnson et al. | 62/23 |

OTHER PUBLICATIONS

"LNG Supply", LNG Express, vol. IV, No. 1, pp. 1-4, Copyright 1994, Zeus Development Corporation.

ART-UNIT: 344

PRIMARY-EXAMINER: Kilner; Christopher

ATTY-AGENT-FIRM: Goodall; Eleanor V. Christiansen; Jon C.

ABSTRACT:

A method and system for liquefying natural gas using a cryogenic process is described. The method is well suited for producing high methane purity natural gas which can be used as a vehicle fuel. The invention utilizes residue gas from a cryogenic plant as a natural gas feedstock. The natural gas feedstock is condensed by heat exchange with overhead gas from the demethanizer of the cryogenic plant. In the preferred embodiment of the invention the pressure of the condensed natural gas is reduced to a level at which it can be readily stored and transported by expansion through one or more Joule-Thomson valves.

59 Claims, 10 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KMC |
|------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|-----|
| | | | | | | | | | | |

8. Document ID: US 5564277 A

L18: Entry 8 of 23

File: USPT

Oct 15, 1996

US-PAT-NO: 5564277

DOCUMENT-IDENTIFIER: US 5564277 A

TITLE: Dehumidifier for cryogenic refrigeration system

DATE-ISSUED: October 15, 1996

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|--------|-------|----------|---------|
| Martin; Patrick S. | Dallas | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------------------|--------|-------|----------|---------|-----------|
| General Cryogenics Incorporated | Dallas | TX | | | 02 |

APPL-NO: 08/ 402849 [PALM]
DATE FILED: March 31, 1995

PARENT-CASE:

CROSS REFERENCE TO RELATED APPLICATION This is a division of application Ser. No. 08/165,723, filed Dec. 13, 1993, U.S. Pat. No. 5,396,777, which was a division of Ser. No. 08/017,796, filed Feb. 12, 1993, U.S. Pat. No. 5,313,787 which was a division of 07/841,590 filed Feb. 25, 1992 which issued on Apr. 6, 1993 now U.S. Pat. No. 5,199,275, which is a continuation-in-part of application Ser. No. 07/651,206 filed Feb. 6, 1991, entitled "ENTHALPY CONTROL FOR CO.₂ REFRIGERATION SYSTEM", U.S. Pat. No. 5,090,209 which is a continuation-in-part of application Ser. No. 07/591,386 filed Oct. 1, 1990 entitled "CARBON DIOXIDE REFRIGERATION SYSTEM" now U.S. Pat. No. 5,069,039 which issued Dec. 3, 1991.

INT-CL: [06] F25 D 21/06

US-CL-ISSUED: 62/50.3, 62/283, 62/526
US-CL-CURRENT: 62/50.3, 62/283, 62/526

FIELD-OF-SEARCH: 62/272, 62/283, 62/526, 62/50.1, 62/50.2, 62/50.3, 62/50.4, 62/50.7, 62/51.1, 62/52.1, 62/80

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|-----------------------|---------|
| <u>2847190</u> | August 1958 | Slattery et al. | |
| <u>3010288</u> | November 1961 | Jacobs | |
| <u>3023589</u> | March 1962 | Jacobs | |
| <u>3307366</u> | March 1967 | Smith | |
| <u>3309887</u> | March 1967 | Jacobus | |
| <u>3309888</u> | March 1967 | Jacobs | |
| <u>3335576</u> | August 1967 | Philips | |
| <u>3495416</u> | February 1970 | Morrissey, Jr. et al. | |
| <u>3802212</u> | April 1974 | Martin et al. | |
| <u>3861165</u> | January 1975 | Hirano | 62/283 |
| <u>3861167</u> | January 1975 | Nijo | |
| <u>4045972</u> | September 1977 | Tyree, Jr. | 62/156 |
| <u>4100759</u> | July 1978 | Tyree, Jr. | |
| <u>4186562</u> | February 1980 | Tyree, Jr. | 62/62 |
| <u>4271899</u> | June 1981 | Noland | |
| <u>4498306</u> | February 1985 | Tyree, Jr. | 62/119 |
| <u>5069039</u> | December 1991 | Martin | |
| <u>5090209</u> | February 1992 | Martin | 62/50.3 |
| <u>5199275</u> | April 1993 | Martin | |
| <u>5313787</u> | May 1994 | Martin | |
| <u>5396777</u> | March 1995 | Martin | |

OTHER PUBLICATIONS

Refrigerated Containerized Transport for "Jumbo" Jets, L. Tyree, Jr., 1971, pp. 521-525.

The Refrigerant Delemma, Kira Gould, Fleet Owner, Sep. 1989, pp. 94-100.

Cryogenic Refrigeration: Wave of the Future?, Ken Stadden, Heavy Duty Trucking, Jul. 1990, p. 128.

ART-UNIT: 344

PRIMARY-EXAMINER: Tanner; Harry B.

ATTY-AGENT-FIRM: Crutsinger & Booth

ABSTRACT:

A method and apparatus to refrigerate air in a compartment wherein liquid CO.₂ is delivered through a first primary heat exchanger such that sufficient heat is absorbed to evaporate the liquid carbon dioxide to form pressurized vapor. The pressurized vapor is heated in a gas fired heater to prevent solidification of the pressurized carbon dioxide when it is depressurized to provide isentropic expansion of the vapor through pneumatically driven fan motors into a secondary heat exchanger. Orifices in inlets to the fan motors and solenoid valves in flow lines to the fan motors keep the vapor pressurized while the heater supplies sufficient heat to prevent solidification when the CO.₂ vapor expands through the motors. CO.₂ vapor is routed from the second heat exchanger to chill surfaces in a dehumidifier to condense moisture from a stream of air before it flows to the heat exchangers.

12 Claims, 8 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments |
|------------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|
| Draw. Desc | Image | | | | | | | | |

KMC

9. Document ID: US 5551972 A

US-PAT-NO: 5551972
DOCUMENT-IDENTIFIER: US 5551972 A

TITLE: Absorption process without external solvent

DATE-ISSUED: September 3, 1996

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|----------------|---------------|-------|----------|---------|
| Wood; Glenn C. | Houston | TX | | |
| Mehra; Yuv R. | The Woodlands | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE | CODE |
|--|---------|-------|----------|---------|------|------|
| Advanced Extraction Technologies, Inc. | Houston | TX | | | | 02 |

APPL-NO: 08/ 518145 [PALM]
DATE FILED: August 23, 1995

PARENT-CASE:

This application is a divisional of application Ser. No. 08/206,420 filed Mar. 4, 1994, issued as U.S. Pat. No. 5,462,583.

INT-CL: [06] B01 D 47/14

US-CL-ISSUED: 95/192; 95/96, 95/143, 95/208, 95/230, 95/237, 585/809
US-CL-CURRENT: 95/192; 585/809, 95/143, 95/208, 95/230, 95/237, 95/96

FIELD-OF-SEARCH: 95/96, 95/187, 95/192, 95/141, 95/208, 95/127-130, 95/143-147, 95/230-232, 95/237-240, 62/17, 62/20, 585/809, 585/867, 208/101, 208/341, 55/227, 55/228

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|----------------|----------|
| <u>3633371</u> | January 1972 | Davison | 62/17 |
| <u>4035167</u> | July 1977 | Starks | 95/173 |
| <u>4072604</u> | February 1978 | Ward | 208/341 |
| <u>4333819</u> | June 1982 | Scheifele Jr. | 208/101 |
| <u>4368058</u> | January 1983 | Crowley et al. | 55/227 X |
| <u>4421535</u> | December 1983 | Mehra | 62/17 |
| <u>4494967</u> | January 1985 | Barth | 55/228 X |
| <u>4526594</u> | July 1985 | Mehra | 62/17 |
| <u>4578094</u> | March 1986 | Mehra | 62/17 |
| <u>4617038</u> | October 1986 | Mehra | 62/17 |
| <u>4623371</u> | November 1986 | Mehra | 62/17 |
| <u>4680042</u> | July 1987 | Mehra | 62/17 |
| <u>4692179</u> | September 1987 | Mehra | 62/17 |
| <u>4695672</u> | September 1987 | Bunting | 585/867 |
| <u>4696688</u> | September 1987 | Mehra | 62/17 |
| <u>4740222</u> | April 1988 | Mehra | 62/17 |
| <u>4743282</u> | May 1988 | Mehra | 62/17 |
| <u>4832718</u> | May 1989 | Mehra | 62/17 |
| <u>4883514</u> | November 1989 | Mehra | 62/17 |
| <u>4883515</u> | November 1989 | Mehra et al. | 62/17 |
| <u>5220097</u> | June 1993 | Lam et al. | 585/809 |
| <u>5224350</u> | July 1993 | Mehra | 62/20 X |
| <u>5321952</u> | June 1994 | Forte | 62/17 |
| <u>5326929</u> | July 1994 | Mehra et al. | 62/17 X |
| <u>5462583</u> | October 1995 | Wood et al. | 95/192 |

FOREIGN PATENT DOCUMENTS

| FOREIGN-PAT-NO | PUBN-DATE | COUNTRY | US-CL |
|----------------|------------|---------|-------|
| 3031727 | April 1982 | DE | |
| 3132292 | March 1983 | DE | |

OTHER PUBLICATIONS

Szatny et al., "Reporting Performance of a Field Test of The Mehra Process Nitrogen Rejection Unit," Gas Research Institute, Topical Report (Nov. 1993), Houston, Texas, pp. 1-17.

"Mehra vs. Cold-Box: The Final Chapter," Gas Processors Report (Sep. 6, 1993), Houston Texas.

"Cold-Box Answers Back," Gas Processors Report (Jul. 12, 1993), Houston, Texas.

"Mehra Plant Beats Computer," Gas processors Report (Jun. 14, 1993), Houston, Texas.

Mehra et al., "Noncryogenic N.sub.2 -rejection process gets Hugoton field test," Oil & Gas Journal (May 24, 1993), pp. 62-71.

Mehra et al., "Non-Cryogenic Absorption-Based Mehra Process Technology Upgrades Hugoton Gases," Advances in Nitrogen Rejection Tech. Sym., AIChE '93 Spring Nat'l Mtg. (Mar. 29, 1993), Houston, Texas, pp. 1-15.

Yuv R. Mehra, "Can We Really Afford to Keep Burning Light Olefins and Hydrogen in our Refineries?," CMAI Seminar, Houston, Texas (Mar. 24-25, 1993), pp. 1-10.

"Nitrogen Rejection Made Easy," Gas Processors Report (Dec. 7, 1992), Houston, Texas.

Yuv R. Mehra, "Using Non-Cryogenic Absorption to Reject Nitrogen From Subquality Natural Gases," Gas Separation International (Apr. 22-24, 1991), Austin, Texas, pp. 1-13.

James J. L. Ma, "Comparison of the Mehra Process for Nitrogen Rejection to a Cryogenic Process for Nitrogen Rejection from Subquality Natural Gas," Topical Report (Mar. 1991).

Pruitt et al., "Wyoming's Shute Creek plant uses NRU . . . , " Oil & Gas Journal

(Oct. 9, 1989) Technology, pp. 78-80.
Yuv R. Mehra, "Recover and Purify Hydrogen Economically," NPRA Annual Meeting (Mar. 29-31, 1987), San Antonio, Texas.
Yuv R. Mehra, "Process Flexibility Improves Gas Processing Margins", 66th Annual GPA Convention (Mar. 16-18, 1987), Denver, Co.
Yuv R. Mehra, "Processing Hydrocarbon Gases with the Mehra Process Technology," Chemical Engineering (Oct. 27, 1986), Houston, Texas.
Fair et al., "Ethylene purification -demethanization, " Chemical Eng. Progress, vol. 54, NO. 12, (Dec. 1958), pp. 39-47.

ART-UNIT: 135

PRIMARY-EXAMINER: Chiesa; Richard L.

ATTY-AGENT-FIRM: Arnold, White & Durkee

ABSTRACT:

An absorption process for separating a feed gas stream having components with a spectrum of volatilities including volatile (light) components, intermediate volatility components, and least volatile (heavy) components. The disclosed process includes the steps of: (1) contacting the feed gas stream with an internally generated liquid lean solvent stream in an absorber to produce a light product gas stream that is composed of predominantly light components and a rich solvent stream containing most of the intermediate and heavy components; (2) flashing the rich solvent stream at reduced pressure in a flash zone to produce an intermediate product gas stream composed predominantly of intermediate components and a lean solvent stream; (3) conveying the lean solvent stream from the flashing zone to the absorber, wherein the lean solvent is composed predominantly of heavy components supplied from the feed; the process does not use an external lean solvent. The process is particularly useful for rejecting nitrogen from natural gas and for recovering hydrogen from refinery and petrochemical process offgases.

14 Claims, 3 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KMPC |
|-----------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| Draw Desc | Image | | | | | | | | | |

10. Document ID: US 5462583 A

L18: Entry 10 of 23

File: USPT

Oct 31, 1995

US-PAT-NO: 5462583

DOCUMENT-IDENTIFIER: US 5462583 A

** See image for Certificate of Correction **

TITLE: Absorption process without external solvent

DATE-ISSUED: October 31, 1995

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|----------------|---------------|-------|----------|---------|
| Wood; Glenn C. | Houston | TX | | |
| Mehra; Yuv R. | The Woodlands | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE | CODE |
|--|---------|-------|----------|---------|------|------|
| Advanced Extraction Technologies, Inc. | Houston | TX | | | | 02 |

APPL-NO: 08/ 206420 [PALM]

DATE FILED: March 4, 1994

US-CL-ISSUED: 95/192, 62/20, 95/96, 95/143, 95/208, 95/230, 95/237, 585/809
 US-CL-CURRENT: 95/192, 585/809, 62/634, 62/938, 95/143, 95/208, 95/230, 95/237,
95/96

FIELD-OF-SEARCH: 95/187, 95/192, 95/208, 95/141, 95/127-130, 95/143-147, 95/230-232,
 95/237-240, 95/96, 62/17, 62/20, 585/809, 585/867

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|---------|
| <u>3633371</u> | January 1972 | Davison | 62/17 |
| <u>4035167</u> | July 1977 | Starks | 95/173 |
| <u>4421535</u> | December 1983 | Mehra | 62/17 |
| <u>4526594</u> | July 1985 | Mehra | 62/17 |
| <u>4578094</u> | March 1986 | Mehra | 62/17 |
| <u>4617038</u> | October 1986 | Mehra | 62/17 |
| <u>4623371</u> | November 1986 | Mehra | 62/17 |
| <u>4680042</u> | July 1987 | Mehra | 62/17 |
| <u>4692179</u> | September 1987 | Mehra | 62/17 |
| <u>4695672</u> | September 1987 | Bunting | 585/867 |
| <u>4696688</u> | September 1987 | Mehra | 62/17 |
| <u>4740222</u> | April 1988 | Mehra | 62/17 |
| <u>4743282</u> | May 1988 | Mehra | 62/17 |
| <u>4832718</u> | May 1989 | Mehra | 62/17 |
| <u>4883514</u> | November 1989 | Mehra | 62/17 |
| <u>4883515</u> | November 1989 | Mehra et al. | 62/17 |
| <u>5220097</u> | June 1993 | Lam et al. | 585/809 |
| <u>5224350</u> | July 1993 | Mehra | 62/20 X |
| <u>5326929</u> | July 1994 | Mehra et al. | 62/17 X |

OTHER PUBLICATIONS

Szatny et al., "Reporting Performance of a Field Test of The Mehra Process Nitrogen Rejection Unit," Gas Research Institute, Topical Report (Nov. 1993), Houston, Tex., pp. 1-17.

"Mehra vs. Cold-Box: The Final Chapter," Gas Processors Report (Sep. 6, 1993), Houston, Tex.

"Cold-Box Answers Back," Gas Processors Report (Jul. 12, 1993), Houston, Tex.

"Mehra Plant Beats Computer", Gas Processors Report (Jun. 14, 1993), Houston, Tex.

Mehra et al., "Noncryogenic N.sub.2 -rejection process gets Hugoton field test," Oil & Gas Journal (May 24, 1993), pp. 62-71.

Mehra et al., "Non-Cryogenic Absorption-Based Mehra Process Technology Upgrades Hugoton Gases," Advances in Nitrogen Rejection Tech. Sym., AlChE '93 Spring Nat'l Mtg. (Mar. 29, 1993), Houston, Tex., pp. 1-15.

Yuv R. Mehra, "Can We Really Afford to Keep Burning Light Olefins and Hydrogen in our Refineries?," CMAI Seminar, Houston, Tex. (Mar. 24-25, 1993), pp. 1-10.

"Nitrogen Rejection Made Easy," Gas Processors Report (Dec. 7, 1992), Houston, Tex.

Yuv R. Mehra, "Using Non-Cryogenic Absorption to Reject Nitrogen From Subquality Natural Gases," Gas Separation International (Apr. 22-24, 1991), Austin, Tex., pp. 1-13.

James J. L. Ma, "Comparison of the Mehra Process for Nitrogen Rejection to a Cryogenic Process for Nitrogen Rejection from Subquality Natural Gas," Topical Report (Mar. 1991).

Pruitt et al., "Wyoming's Shute Creek plant uses NRU . . . , " Oil & Gas Journal (Oct. 9, 1989) Technology, pp. 78-82.

Yuv R. Mehra, "Recover and Purify Hydrogen Economically," NPRA Annual Meeting (Mar. 29-31, 1987), San Antonio, Tex.

Yuv R. Mehra, "Mehra Process Flexibility Improves Gas Processing Margins," 66th

Annual GPA Convention (Mar. 16-18, 1987), Denver, Colo.
Yuv R. Mehra, "Processing Hydrocarbon Gases with the Mehra Process Technology,"
Chemical Engineering (Oct. 27, 1986), Houston, Tex.
Fair et al., "Ethylene purification--demethanization," Chemical Eng. Progress, vol.
54, No. 12 (Dec. 1958), pp. 39-47.

ART-UNIT: 135

PRIMARY-EXAMINER: Chiesa, Richard L.

ATTY-AGENT-FIRM: Arnold, White & Durkee

ABSTRACT:

An absorption process for separating a feed gas stream having components with a spectrum of volatilities including volatile (light) components, intermediate volatility components, and least volatile (heavy) components. The disclosed process includes the steps of: (1) contacting the feed gas stream with a liquid lean solvent stream in an absorber to produce a light product gas stream that is composed of predominantly light components and a rich solvent stream containing most of the intermediate and heavy components; (2) flashing the rich solvent stream at reduced pressure in a flash zone to produce an intermediate product gas stream composed predominantly of intermediate components and a lean solvent stream; (3) conveying the lean solvent stream from the flashing zone to the absorber, wherein the lean solvent is composed predominantly of heavy components taken from the feed; the process does not use an external lean solvent. The process is particularly useful for rejecting nitrogen from natural gas and for recovering hydrogen from refinery and petrochemical process off-gases.

14 Claims, 3 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KMC |
|------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|-----|
| | | | | | | | | | | |

11. Document ID: US 5396777 A

L18: Entry 11 of 23

File: USPT

Mar 14, 1995

US-PAT-NO: 5396777

DOCUMENT-IDENTIFIER: US 5396777 A

** See image for Certificate of Correction **

TITLE: Defrost controller

DATE-ISSUED: March 14, 1995

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|--------|-------|----------|---------|
| Martin, Patrick S. | Dallas | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------------------|--------|-------|----------|---------|-----------|
| General Cryogenics Incorporated | Dallas | TX | | | 02 |

APPL-NO: 08/ 165723 [PALM]

DATE FILED: December 13, 1993

PARENT-CASE:

CROSS REFERENCE TO RELATED APPLICATION This is a division of application Ser. No. 08/017,796, filed Feb. 12, 1993, U.S. Pat. No. 5,313,787, which was a division of U.S. Pat. No. 07/841,590, filed Feb. 25, 1992, which issued on Apr. 6, 1993, now U.S. Pat. No. 5,199,275, which application is a continuation-in-part of application

Ser. No. 07/651,206, filed Feb. 6, 1991, entitled "ENTHALPY CONTROL FOR CO.₂ sub.2 REFRIGERATION SYSTEM", U.S. Pat. No. 5,090,209, which is a continuation-in-part of application Ser. No. 07/591,386, filed Oct. 1, 1990, entitled "CARBON DIOXIDE REFRIGERATION SYSTEM", now U.S. Pat. No. 5,069,039, which issued Dec. 3, 1991.

INT-CL: [06] F25 D 21/06

US-CL-ISSUED: 62/156
US-CL-CURRENT: 62/156

FIELD-OF-SEARCH: 62/156, 62/155, 62/151, 62/140, 62/276, 62/80, 62/81

PRIOR-ART-DISCLOSED:

U. S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|-----------------------|----------|
| <u>2847190</u> | August 1958 | Slattery et al. | 62/156 X |
| <u>3010288</u> | November 1961 | Jacobs | 62/156 X |
| <u>3023589</u> | March 1962 | Jacobs | 62/156 |
| <u>3309887</u> | March 1967 | Jacobus | 62/156 |
| <u>3309888</u> | March 1967 | Jacobs | 62/156 |
| <u>3495416</u> | February 1970 | Morrissey, Jr. et al. | 62/156 |
| <u>4045972</u> | September 1977 | Tyree, Jr. | 62/156 |

ART-UNIT: 344

PRIMARY-EXAMINER: Tanner; Harry B.

ATTY-AGENT-FIRM: Crutsinger & Booth

ABSTRACT:

A method and apparatus to refrigerate air in a compartment wherein liquid CO.₂ sub.2 is delivered through a first primary heat exchanger such that sufficient heat is absorbed to evaporate the liquid carbon dioxide to form pressurized vapor. The pressurized vapor is heated in a gas fired heater to prevent solidification of the pressurized carbon dioxide when it is depressurized to provide isentropic expansion of the vapor through pneumatically driven fan motors into a secondary heat exchanger. Orifices in inlets to the fan motors and solenoid valves in flow lines to the fan motors keep the vapor pressurized while the heater supplies sufficient heat to prevent solidification when the CO.₂ sub.2 vapor expands through the motors. CO.₂ sub.2 vapor is routed from the second heat exchanger to chill surfaces in a dehumidifier to condense moisture from a stream of air before it flows to the heat exchangers.

8 Claims, 8 Drawing figures

| | | | | | | | | | | |
|-----------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|-------|
| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KMC |
| Draw Desc | | | | | | | | | | Image |

12. Document ID: US 5363655 A

L18: Entry 12 of 23

File: USPT

Nov 15, 1994

US-PAT-NO: 5363655

DOCUMENT-IDENTIFIER: US 5363655 A

TITLE: Method for liquefying natural gas

DATE-ISSUED: November 15, 1994

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|---------------------|----------|-------|----------|---------|
| Kikkawa; Yoshitsugi | Kanagawa | | | JP |
| Yamamoto; Osamu | Kanagawa | | | JP |
| Sakaguchi; Junichi | Kanagawa | | | JP |
| Nakamura; Moritaka | Kanagawa | | | JP |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------|----------|-------|----------|---------|-----------|
| Chiyoda Corporation | Kanagawa | | | JP | 03 |

APPL-NO: 08/ 028025 [PALM]

DATE FILED: March 8, 1993

FOREIGN-APPL-PRIORITY-DATA:

| COUNTRY | APPL-NO | APPL-DATE |
|---------|----------|-------------------|
| JP | 4-335540 | November 20, 1992 |

INT-CL: [05] F25J 1/00

US-CL-ISSUED: 62/9; 62/23, 62/39

US-CL-CURRENT: 62/613

FIELD-OF-SEARCH: 62/9, 62/23, 62/39

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|---------------|-------|
| <u>4229195</u> | October 1980 | Forg | 62/23 |
| <u>4256476</u> | March 1981 | Van Baush | 62/23 |
| <u>4303427</u> | December 1981 | Krieger | 62/23 |
| <u>4619679</u> | October 1986 | DeLong | 62/39 |

ART-UNIT: 344

PRIMARY-EXAMINER: Capossela; Ronald C.

ATTY-AGENT-FIRM: Skjerven, Morrill, MacPherson, Franklin & Friel

ABSTRACT:

Provided is a method for liquefying natural gas which can be readily adapted to LNG plants of all sizes without requiring expensive and special heat exchangers. The liquefaction of feed gas of natural gas and recycle natural gas is carried out with a single-component refrigerant or a mixed refrigerant in a high temperature stage, and with a substantially isentropic expansion in a low temperature stage, and a non-liquefied part of the recycle gas after the expansion step is pressurized with a compressor and recycled along with a recycle stream of non-liquefied part of the feed natural gas, the liquefied part by the refrigerant exchanging heat with the non-liquefied part stream produced from the substantially isentropic expansion, in a plate-fin heat exchanger or the like. The compressor is driven by the power obtained by the substantially isentropic expansion.

12 Claims, 12 Drawing figures

13. Document ID: US 5313787 A

L18: Entry 13 of 23

File: USPT

May 24, 1994

US-PAT-NO: 5313787

DOCUMENT-IDENTIFIER: US 5313787 A

** See image for Certificate of Correction **

TITLE: Refrigeration trailer

DATE-ISSUED: May 24, 1994

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|--------|-------|----------|---------|
| Martin; Patrick S. | Dallas | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------------------|--------|-------|----------|---------|-----------|
| General Cryogenics Incorporated | Dallas | TX | | | 02 |

APPL-NO: 08/ 017796 [PALM]

DATE FILED: February 12, 1993

PARENT-CASE:

CROSS REFERENCE TO RELATED APPLICATION This is a division of application Ser. No. 07/841,590 filed Feb. 25, 1992, now U.S. Pat. No. 5,199,275 which is a continuation-in-part of application Ser. No. 07/651,206 filed Feb. 6, 1991, entitled "ENTHALPY CONTROL FOR CO₂ REFRIGERATION SYSTEM" now U.S. Pat. No. 5,090,209, which is a continuation-in-part of application Ser. No. 07/591,386 filed Oct. 1, 1990 entitled "CARBON DIOXIDE REFRIGERATION SYSTEM", now U.S. Pat. No. 5,069,039 which issued Dec. 3, 1991.

INT-CL: [05] F25B 41/04

US-CL-ISSUED: 62/222; 62/50.3, 62/51.1, 62/50.4, 62/275

US-CL-CURRENT: 62/222; 62/275, 62/50.3, 62/50.4, 62/51.1

FIELD-OF-SEARCH: 62/50.1, 62/50.2, 62/50.3, 62/50.4, 62/50.7, 62/51.1, 62/52.1, 62/272, 62/151, 62/156, 62/275, 62/80, 62/82, 62/222, 62/224, 62/225, 62/217

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|-----------|
| <u>3307366</u> | March 1967 | Smith | 62/51.1 X |
| <u>3335576</u> | August 1967 | Philips | 62/156 |
| <u>3802212</u> | April 1974 | Martin et al. | 62/52 |
| <u>3861167</u> | January 1975 | Nijo | 62/156 X |
| <u>4045972</u> | September 1977 | Tyree, Jr. | 62/51.1 X |
| <u>4100759</u> | July 1978 | Tyree, Jr. | 62/165 X |
| <u>4186562</u> | February 1980 | Tyree, Jr. | 62/51.1 X |
| <u>4271899</u> | June 1981 | Noland | 62/156 X |
| <u>4498306</u> | February 1985 | Tyree, Jr. | 62/239 X |
| <u>5069039</u> | December 1991 | Martin | 62/50.3 |
| <u>5090209</u> | February 1992 | Martin | 62/50.3 |

OTHER PUBLICATIONS

Refrigerated Containerized Transport for "Jumbo" Jets, L. Tyree, Jr., 1971, pp. 521-525.

The Refrigerant Dilemma, Kira Gould, Fleet Owner, Sep. 1989, pp. 94-100.

Cryogenic Refrigeration: Wave of the Future?, Ken Stadden, Heavy Duty Trucking, Jul. 1990, p. 128.

ART-UNIT: 344

PRIMARY-EXAMINER: Tanner; Harry B.

ATTY-AGENT-FIRM: Crutsinger & Booth

ABSTRACT:

A method and apparatus to refrigerate air in a compartment wherein liquid CO.₂ is delivered through a first primary heat exchanger such that sufficient heat is absorbed to evaporate the liquid carbon dioxide to form pressurized vapor. The pressurized vapor is heated in a gas fired heater to prevent solidification of the pressurized carbon dioxide when it is depressurized to provide isentropic expansion of the vapor through pneumatically driven fan motors into a secondary heat exchanger. Orifices in inlets to the fan motors and solenoid valves in flow lines to the fan motors keep the vapor pressurized while the heater supplies sufficient heat to prevent solidification when the CO.₂ vapor expands through the motors. CO.₂ vapor is routed from the second heat exchanger to chill surfaces in a dehumidifier to condense moisture from a stream of air before it flows to the heat exchangers.

11 Claims, 8 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments |
|-----------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|
| Draw Desc | Image | | | | | | | | KMC |

14. Document ID: US 5199275 A

L18: Entry 14 of 23

File: USPT

Apr 6, 1993

US-PAT-NO: 5199275

DOCUMENT-IDENTIFIER: US 5199275 A

TITLE: Refrigeration trailer

DATE-ISSUED: April 6, 1993

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|--------|-------|----------|---------|
| Martin; Patrick S. | Dallas | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------------------|--------|-------|----------|---------|-----------|
| General Cryogenics Incorporated | Dallas | TX | | | 02 |

APPL-NO: 07/ 841590 [PALM]
 DATE FILED: February 25, 1992

PARENT-CASE:

CROSS REFERENCE TO RELATED APPLICATION This application is a continuation-in-part of application Ser. No. 07/651,206 filed Feb. 6, 1991, entitled "ENTHALPY CONTROL FOR CO.₂ REFRIGERATION SYSTEM" now U.S. Pat. No. 5,090,209 which is a continuation-in-part of application Ser. No. 07/591,386 filed Oct. 1, 1990 entitled "CARBON DIOXIDE REFRIGERATION SYSTEM", now U.S. Pat. No. 5,069,039 which issued Dec. 3, 1991.

INT-CL: [05] F25D 21/06

US-CL-ISSUED: 62/275, 62/156, 62/50.3
 US-CL-CURRENT: 62/275, 62/156, 62/50.3

FIELD-OF-SEARCH: 62/50.1, 62/50.2, 62/50.3, 62/50.4, 62/50.7, 62/51.1, 62/52.1, 62/140, 62/156, 62/272, 62/275, 62/276, 62/526, 62/80, 62/81, 62/239

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|---------|
| <u>3307366</u> | March 1967 | Smith | 62/5 |
| <u>3335576</u> | August 1967 | Philips | 62/156 |
| <u>3802212</u> | April 1974 | Martin et al. | 62/52 |
| <u>3861167</u> | January 1975 | Nijo | 62/209 |
| <u>4045972</u> | September 1977 | Tyree, Jr. | 62/156 |
| <u>4100759</u> | July 1978 | Tyree, Jr. | 62/55 |
| <u>4186562</u> | February 1980 | Tyree, Jr. | 62/62 |
| <u>4271899</u> | June 1981 | Noland | 165/29 |
| <u>4498306</u> | February 1985 | Tyree, Jr. | 62/119 |
| <u>5069039</u> | December 1991 | Martin | 62/50.3 |
| <u>5090209</u> | February 1992 | Martin | 62/50.3 |

OTHER PUBLICATIONS

Refrigerated Containerized Transport for "Jumbo" Jets, L. Tyree, Jr., 1971, pp. 521-525.

The Refrigerant Dilemma, Kira Gould, Fleet Owner, Sep. 1989, pp. 94-100.

Cryogenic Refrigeration: Wave of the Future?, Ken Stadden, Heavy Duty Trucking, Jul. 1990, p. 128.

ART-UNIT: 344

PRIMARY-EXAMINER: Tanner; Harry B.

ATTY-AGENT-FIRM: Crutsinger & Booth

ABSTRACT:

A method and apparatus to refrigerate air in a compartment wherein liquid CO.₂ is delivered through a first primary heat exchanger such that sufficient heat is

absorbed to evaporate the liquid carbon dioxide to form pressurized vapor. The pressurized vapor is heated in a gas fired heater to prevent solidification of the pressurized carbon dioxide when it is depressurized to provide isentropic expansion of the vapor through pneumatically driven fan motors into a secondary heat exchanger. Orifices in inlets to the fan motors and solenoid valves in flow lines to the fan motors keep the vapor pressurized while the heater supplies sufficient heat to prevent solidification when the CO₂ vapor expands through the motors. CO₂ vapor is routed from the second heat exchanger to chill surfaces in a dehumidifier to condense moisture from a stream of air before it flows to the heat exchangers.

12 Claims, 8 Drawing figures

| | | | | | | | | | | |
|---|-----------------------|--------------------------|-----------------------|------------------------|--------------------------------|----------------------|---------------------------|---------------------------|-----------------------------|----------------------|
| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KOMC |
| Draw Desc Image | | | | | | | | | | |

15. Document ID: US 5069039 A

L18: Entry 15 of 23

File: USPT

Dec 3, 1991

US-PAT-NO: 5069039

DOCUMENT-IDENTIFIER: US 5069039 A

** See image for Certificate of Correction **

TITLE: Carbon dioxide refrigeration system

DATE-ISSUED: December 3, 1991

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|--------|-------|----------|---------|
| Martin; Patrick S. | Dallas | TX | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|---------------------------------|--------|-------|----------|---------|-----------|
| General Cryogenics Incorporated | Dallas | TX | | | 02 |

APPL-NO: 07/ 591386 [PALM]

DATE FILED: October 1, 1990

INT-CL: [05] F25D 21/06

US-CL-ISSUED: 62/50.3; 62/156, 62/272, 62/526

US-CL-CURRENT: 62/50.3; 62/156, 62/272, 62/526

FIELD-OF-SEARCH: 62/156, 62/50.1, 62/50.2, 62/50.3, 62/50.4, 62/50.7, 62/526, 62/275, 62/272

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|-----------|
| <u>3307366</u> | March 1967 | Smith | 62/50.1 X |
| <u>3335576</u> | August 1967 | Phillips | 62/156 |
| <u>3802212</u> | April 1974 | Martin et al. | 62/52 |
| <u>3861167</u> | January 1975 | Nojo | 62/156 X |
| <u>4045972</u> | September 1977 | Tyree, Jr. | 62/156 |
| <u>4100759</u> | July 1978 | Tyree, Jr. | 62/165 X |
| <u>4186562</u> | February 1980 | Tyree, Jr. | 62/62 |
| <u>4498306</u> | February 1985 | Tyree, Jr. | 62/119 |

OTHER PUBLICATIONS

Refrigerated Containerized Transport for "Jumbo" Jets, L. Tyree, Jr., 1971, pp. 521-525.

The Refrigerant Dilemma, Kira Gould, Fleet Owner, Sep. 1989, pp. 94-100.

Cryogenic Refrigeration: Wave of the Future?, Ken Stadden, Heavy Duty Trucking, Jul. 1990, p. 128.

ART-UNIT: 344

PRIMARY-EXAMINER: Tanner; Harry B.

ATTY-AGENT-FIRM: Crutsinger & Booth

ABSTRACT:

A method and apparatus to refrigerate air in a compartment wherein liquid dioxide is delivered through a first primary heat exchanger such that sufficient heat is absorbed to evaporate the liquid carbon dioxide to form pressurized vapor. The pressurized vapor is heated in an external heat exchanger to prevent solidification of the pressurized carbon dioxide when it is depressurized to provide isentropic expansion of the vapor into a secondary heat exchanger. Pneumatically driven motors are driven by the pressurized carbon dioxide vapor to move air across the heat exchangers. Orifices in inlets to the motors and solenoid valves in flow lines to the motors keep the vapor pressurized while the external heat exchanger supplies sufficient heat to prevent solidification when it expands through the motors.

16 Claims, 2 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|------------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| Drawn Desc | Image | | | | | | | | | |

16. Document ID: US 5036671 A

L18: Entry 16 of 23

File: USPT

Aug 6, 1991

US-PAT-NO: 5036671

DOCUMENT-IDENTIFIER: US 5036671 A

TITLE: Method of liquefying natural gas

DATE-ISSUED: August 6, 1991

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------|---------------|-------|----------|---------|
| Nelson; Warren L. | Orinda | CA | | |
| Garcia; Luc | San Francisco | CA | | |

ASSIGNEE-INFORMATION:

NAME CITY STATE ZIP CODE COUNTRY TYPE CODE
Liquid Air Engineering Company Montreal CA 03

APPL-NO: 07/ 475908 [PALM]
DATE FILED: February 6, 1990

INT-CL: [05] F25J 3/06

US-CL-ISSUED: 62/23; 62/48.2
US-CL-CURRENT: 62/612; 62/48.2

FIELD-OF-SEARCH: 62/11, 62/38, 62/39, 62/23, 62/48.2

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|-----------------|-------|
| <u>3616652</u> | November 1971 | Engel | 62/11 |
| <u>4638639</u> | January 1987 | Marshall et al. | 62/38 |
| <u>4740223</u> | April 1988 | Gates | 62/38 |
| <u>4758257</u> | July 1988 | Gates | 62/38 |

ART-UNIT: 344

PRIMARY-EXAMINER: Capossela, Ronald C.

ATTY-AGENT-FIRM: Oblon, Spivak, McClelland, Maier & Neustadt

ABSTRACT:

A method of producing a methane-rich liquid stream from a stream of natural gas predominantly consisting of methane and also containing nitrogen, entailing:

- (a) supplying said natural gas stream at a pressure above atmospheric pressure,
- (b) cooling and liquefying said natural gas stream using one or more refrigeration cycles, and
- (c) expanding said liquefied natural gas to lower pressure in two or more stages in series, phase separating the gas and liquid phases produced during the expansion, thereby concentrating the nitrogen into the vapor phase, and producing a methane-rich liquefied natural gas.

25 Claims, 1 Drawing figures

[Full](#) | [Title](#) | [Citation](#) | [Front](#) | [Review](#) | [Classification](#) | [Date](#) | [Reference](#) | [Sequences](#) | [Attachments](#) | [KMC](#) |
[Drawn Desc](#) | [Image](#) |

17. Document ID: US 4846862 A

L18: Entry 17 of 23

File: USPT

Jul 11, 1989

US-PAT-NO: 4846862

DOCUMENT-IDENTIFIER: US 4846862 A

TITLE: Reliquefaction of boil-off from liquefied natural gas

DATE-ISSUED: July 11, 1989

INVENTOR-INFORMATION:

| | | | | |
|-----------------|---------------|-------|----------|---------|
| NAME | CITY | STATE | ZIP CODE | COUNTRY |
| Cook; Philip J. | Schnecksville | PA | | |

ASSIGNEE-INFORMATION:

| | | | | | |
|----------------------------------|-----------|-------|----------|---------|-----------|
| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
| Air Products and Chemicals, Inc. | Allentown | PA | | | 02 |

APPL-NO: 07/ 241158 [PALM]
DATE FILED: September 6, 1988

INT-CL: [04] F25J 1/00

US-CL-ISSUED: 62/9, 62/51.1, 62/54.1
US-CL-CURRENT: 62/48.2, 62/51.1, 62/54.1

FIELD-OF-SEARCH: 62/54, 62/514R, 62/9

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|------------------|-------|
| <u>3347055</u> | October 1967 | Blanchard et al. | 62/54 |
| <u>3780534</u> | December 1973 | Lofredo et al. | 62/54 |
| <u>3857245</u> | December 1974 | Jones | 62/54 |
| <u>3857251</u> | December 1974 | Alleaume | 62/54 |
| <u>3874185</u> | April 1975 | Etzbach | 62/54 |
| <u>3889485</u> | June 1975 | Swearingen | 62/54 |
| <u>3919852</u> | November 1975 | Jones | 62/54 |
| <u>4188793</u> | February 1980 | Watson et al. | 62/54 |
| <u>4543794</u> | October 1985 | Matsutani et al. | 62/54 |
| <u>4766741</u> | August 1988 | Bartlett et al. | 62/54 |

ART-UNIT: 344

PRIMARY-EXAMINER: Capossela; Ronald C.

ATTY-AGENT-FIRM: Brewer; Russell L. Simmons; James C. Marsh; William F.

ABSTRACT:

The present invention relates to an improved process for the reliquefaction of boil-off gas containing up to 10% nitrogen resulting from the evaporation of liquefied natural gas (LNG) contained in a storage vessel. In the process, a closed-loop refrigeration cycle is utilized wherein an isenthalpically expanded stream is warmed against an initially cooled boil-off stream. The boil-off LNG stream is initially cooled by indirect heat exchange with an isentropically expanded refrigerant stream.

13 Claims, 3 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|------|-----------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| | Draw Desc | Image | | | | | | | | |

18. Document ID: US 4843829 A

L18: Entry 18 of 23

File: USPT

Jul 4, 1989

US-PAT-NO: 4843829
DOCUMENT-IDENTIFIER: US 4843829 A

TITLE: Reliquefaction of boil-off from liquefied natural gas

DATE-ISSUED: July 4, 1989

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------|-----------|-------|----------|---------|
| Stuber; Wayne G. | Whitehall | PA | | |
| Kovak; Kenneth W. | Macungie | PA | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|----------------------------------|-----------|-------|----------|---------|-----------|
| Air Products and Chemicals, Inc. | Allentown | PA | | | 02 |

APPL-NO: 07/ 266729 [PALM]
DATE FILED: November 3, 1988

INT-CL: [04] F17C 13/00

US-CL-ISSUED: 62/54.2; 62/51.1
US-CL-CURRENT: 62/54.2; 62/51.1

FIELD-OF-SEARCH: 62/54, 62/514R

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|------------------|---------|
| <u>3874185</u> | April 1975 | Etzbach | 62/40 |
| <u>3889485</u> | June 1975 | Swearingen | 62/54 |
| <u>3967938</u> | July 1976 | Daeschler et al. | 62/54 |
| <u>3970441</u> | July 1976 | Etzbach et al. | 62/54 |
| <u>4055961</u> | November 1977 | Admiral | 62/54 |
| <u>4267701</u> | May 1981 | Toscano | 62/514R |
| <u>4437312</u> | March 1984 | Newton et al. | 62/514R |
| <u>4766741</u> | August 1988 | Bartlett et al. | 62/54 |

ART-UNIT: 344

PRIMARY-EXAMINER: Capossela; Ronald C.

ATTY-AGENT-FIRM: Brewer; Russell L. Simmons; James C. Marsh; William F.

ABSTRACT:

The present invention relates to an improved process for the reliquefaction of boil-off gas containing up to 10% nitrogen resulting from the evaporation of liquefied natural gas (LNG) contained in a storage vessel. In the process, a closed-loop nitrogen refrigeration cycle is utilized wherein the nitrogen is isenthalpically expanded under conditions for generating a liquid and vapor with the liquid being pressurized by pumping and warmed against an initially cooled boil-off stream. The boil-off LNG stream is initially cooled by indirect heat exchange with

an isentropically expanded refrigerant stream.

7 Claims, 3 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments |
|---------------------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|
| Drawn Descr Image | | | | | KMIC | | | | |

19. Document ID: US 4522636 A

L18: Entry 19 of 23

File: USPT

Jun 11, 1985

US-PAT-NO: 4522636

DOCUMENT-IDENTIFIER: US 4522636 A

TITLE: Pipeline gas pressure reduction with refrigeration generation

DATE-ISSUED: June 11, 1985

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------------|------------|-------|----------|---------|
| Markbreiter; Stephen J. | Edison | NJ | | |
| Schorr; Hans P. | Douglaston | NY | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|--------------------------------|----------|-------|----------|---------|-----------|
| Kryos Energy Inc. | New York | NY | | | 02 |
| The Brooklyn Union Gas Company | Brooklyn | NY | | | 02 |

APPL-NO: 06/ 578074 [PALM]

DATE FILED: February 8, 1984

INT-CL: [03] B01D 53/14

US-CL-ISSUED: 55/23; 55/32, 55/208, 62/87, 62/402

US-CL-CURRENT: 62/87; 62/402

FIELD-OF-SEARCH: 55/23, 55/29, 55/32, 55/171, 55/208, 62/115-117, 62/86, 62/87, 62/402, 62/88

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|-------------------|---------|
| <u>3002362</u> | October 1961 | Morrison | 62/87 |
| <u>3355903</u> | December 1967 | La Fleur | 62/402 |
| <u>3360944</u> | January 1968 | Knapp et al. | 62/12 |
| <u>3735601</u> | May 1973 | Stannard | 62/87 |
| <u>3886757</u> | June 1975 | McClintock et al. | 62/20 |
| <u>4312851</u> | January 1982 | Isalski et al. | 55/23 X |
| <u>4420950</u> | December 1983 | Bodas et al. | 62/402 |

ART-UNIT: 135

PRIMARY-EXAMINER: Hart; Charles

ABSTRACT:

The high pressure of pipeline gas is reduced to the low pressure of a distribution system with simultaneous generation of refrigeration by passing the gas through two successive centrifugal compressors driven by two turbo-expanders in which the compressed gas is expanded to successively lower pressures. Refrigeration is recovered from the gas as it leaves each turbo-expander. Methanol is injected into the pipeline gas before it is expanded to prevent ice formation. Aqueous methanol condensate separated from the expanded gas is distilled for the recovery and reuse of methanol.

12 Claims, 3 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|--------------------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| Drawn Desc Image | | | | | | | | | | |

20. Document ID: US 4329842 A

L18: Entry 20 of 23

File: USPT

May 18, 1982

US-PAT-NO: 4329842

DOCUMENT-IDENTIFIER: US 4329842 A

TITLE: Power conversion system utilizing reversible energy of liquefied natural gas

DATE-ISSUED: May 18, 1982

INVENTOR-INFORMATION:

| NAME | CITY | STATE ZIP CODE COUNTRY |
|--------------------------------|---------------------------|------------------------|
| Hoskinson, deceased; Robert L. | late of Pacific Palisades | CA |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE CODE |
|-------------------|---------------|-------|----------|---------|-----------|
| Linhardt; Hans D. | Newport Beach | CA | | | 04 |

APPL-NO: 06/ 165378 [PALM]

DATE FILED: July 2, 1980

INT-CL: [03] F02C 7/00, F17C 7/02

US-CL-ISSUED: 60/39.46G; 60/648, 60/727, 60/728, 62/52

US-CL-CURRENT: 60/39.465; 60/648, 60/727, 60/728, 62/50.2

FIELD-OF-SEARCH: 60/648, 60/726, 60/727, 60/728, 60/39.46R, 60/39.46G, 62/52

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|----------------|----------|
| <u>3293850</u> | December 1966 | Morrison | 60/648 |
| <u>3978663</u> | September 1976 | Mandrin et al. | 60/728 |
| <u>3992891</u> | November 1976 | Pocrnja | 60/648 X |

FOREIGN PATENT DOCUMENTS

FOREIGN-PAT-NO
52-109782

PUBN-DATE
March 1977

COUNTRY
JP

US-CL

ART-UNIT: 341

PRIMARY-EXAMINER: Ostrager; Allen M.

ATTY-AGENT-FIRM: Jackson, Jones & Price

ABSTRACT:

A power conversion system comprising a combination of a liquefied natural gas vaporizing plant and a fuel burning power generating facility is disclosed. The liquefied natural gas vaporizing plant utilizes the cryogenic capacity of the liquefied natural gas to produce liquid air which is pumped to a high pressure by a liquid air pump. The liquid air is then brought into a heat exchanging relationship with air drawn into the vaporizing plant so that the high pressure liquid air is converted to high pressure gaseous air. The high pressure gaseous air which represents recovered reversible energy of the liquefied natural gas is fed into a combustion chamber of the fuel burning power generating plant. Since the power generating facility requires no significant output of power to drive a compressor to compress ambient air prior to its entry into the combustion chamber, the power generating facility is operated at a high efficiency.

23 Claims, 5 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
|------|-------|----------|-------|--------|----------------|------|-----------|-----------|-------------|------|
| | | | | | | | | | | |

21. Document ID: US 4158556 A

L18: Entry 21 of 23

File: USPT

Jun 19, 1979

US-PAT-NO: 4158556

DOCUMENT-IDENTIFIER: US 4158556 A

TITLE: Nitrogen-methane separation process and system

DATE-ISSUED: June 19, 1979

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------|---------------|-------|----------|---------|
| Yearout; James D. | Hermosa Beach | CA | 90254 | |

APPL-NO: 05/ 786130 [BALM]

DATE FILED: April 11, 1977

INT-CL: [02] F25J 3/02

US-CL-ISSUED: 62/28, 62/17, 62/39, 62/40, 62/31

US-CL-CURRENT: 62/622, 62/927

FIELD-OF-SEARCH: 62/23, 62/28, 62/27, 62/17, 62/38, 62/39, 62/31, 62/40

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|-------|
| <u>1878123</u> | September 1932 | Etienne | 62/31 |
| <u>2499043</u> | February 1950 | Voorhees | 62/39 |
| <u>2534903</u> | December 1950 | Etienne | 62/39 |
| <u>3074245</u> | January 1963 | Becker | 62/17 |
| <u>3130026</u> | April 1964 | Becker | 62/17 |
| <u>3516262</u> | June 1970 | Bernstein | 62/28 |

ART-UNIT: 177

PRIMARY-EXAMINER: Yudkoff; Norman

ATTY-AGENT-FIRM: Geldin; Max

ABSTRACT:

Method and system designed particularly for separating or removing nitrogen from mixtures of nitrogen and methane, particularly natural gas, over a wide range of nitrogen concentrations, employing low temperature rectification, for recovery of methane containing a substantially reduced amount of nitrogen, either as a gas or a liquid, including the features of regenerative heat exchange to cool the feed mixture to near its saturation point, prior to introduction into a fractionating column, by-passing a small stream of the feed around the regenerative heat exchanger as a means of controlling feed temperature and reboil heat in the column, passing the overhead nitrogen gas from the column in indirect heat exchange relation with the rectifying section of the column to generate reflux continuously along the separation zone, work expansion of the nitrogen waste stream to provide necessary refrigeration, providing downflow evaporation of the liquid product within the column in the case of gas producing plants, and sub-cooling the bottoms liquid product prior to evaporation of the product in the case of a gas producing plant, or prior to isentropic expansion to liquid storage in the case of a liquid producing plant.

20 Claims, 2 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC |
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22. Document ID: US 3735600 A

L18: Entry 22 of 23

File: USPT

May 29, 1973

US-PAT-NO: 3735600

DOCUMENT-IDENTIFIER: US 3735600 A

TITLE: APPARATUS AND PROCESS FOR LIQUEFACTION OF NATURAL GASES

DATE-ISSUED: May 29, 1973

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|-------------------------|-----------|-------|----------|---------|
| Dowdell; Stewart Harold | Oakmont | PA | | |
| Pachaly; Robert W. | Greenwich | CT | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE ZIP CODE | COUNTRY | TYPE | CODE |
|-------------------------------------|---------------|----------------|---------|------|------|
| Gulf Research & Development Company | Pittsburgh PA | | | 02 | |

APPL-NO: 05 / 036277
DATE FILED: May 11, 1970

INT-CL: [] F25j 1/00, F25j 1/02, F25j 3/06

US-CL-ISSUED: 62/39; 62/9, 62/18, 62/26
US-CL-CURRENT: 62/619

FIELD-OF-SEARCH: 62/9, 62/11, 62/23, 62/38, 62/39, 62/40, 62/54, 62/18, 62/26,
62/30, 62/18, 55/33, 55/62

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|----------------|---------------|-------|
| <u>3312073</u> | April 1967 | Jackson | 62/9 |
| <u>3358460</u> | December 1967 | Smith | 62/40 |
| <u>3116135</u> | December 1963 | Filstead | 62/11 |
| <u>2716332</u> | August 1955 | Haynes | 62/39 |
| <u>2940268</u> | June 1960 | Morrison | 62/39 |
| <u>3078634</u> | February 1963 | Milton | 55/62 |
| <u>3087291</u> | April 1963 | Jackson | 55/62 |
| <u>3109722</u> | November 1963 | Dow | 55/33 |
| <u>3150942</u> | September 1964 | Vasan | 55/33 |
| <u>2242299</u> | May 1941 | Harrington | 62/39 |
| <u>2900796</u> | August 1959 | Morrison | 62/9 |

FOREIGN PATENT DOCUMENTS

| FOREIGN-PAT-NO | PUBN-DATE | COUNTRY | US-CL |
|----------------|--------------|---------|-------|
| 612,776 | January 1961 | CA | 62/39 |

ART-UNIT: 175

PRIMARY-EXAMINER: Yudkoff; Norman

ASSISTANT-EXAMINER: Purcell; Arthur F.

ATTY-AGENT-FIRM: Neishloss; Meyer Keith; Deane E. Ryder; Thomas G.

ABSTRACT:

A process and apparatus for liquefaction of natural gas wherein the gas is cooled and liquified under pressure in a heat exchanger-liquifier. The pressurized cold liquid from the heat exchanger-liquifier is isenthalpically expanded to reduce the pressure and further cool the liquid while at the same time flashing a minor gas fraction. Refrigeration for the liquefaction of the natural gas is supplied by a circulating refrigerant stream which is compressed and work-expanded to obtain the necessary cooling. The minor flash gas portion of the liquefaction step is comingled with the circulating refrigerant stream so that the analysis of the refrigerant stream is always rich in the lighter portions of the liquefaction stream. This analysis difference aids in maintaining refrigeration temperature differentials to drive the liquefaction step. The work-expanded refrigerant portion undergoes a compression cycle and is work-expanded in an expansion turbine. The expansion turbine furnishes at least part of the power necessary to drive the compressor system in the refrigerant gas cycle.

13 Claims, 1 Drawing figures

23. Document ID: US 3724226 A

L18: Entry 23 of 23

File: USPT

Apr 3, 1973

US-PAT-NO: 3724226

DOCUMENT-IDENTIFIER: US 3724226 A

TITLE: LNG EXPANDER CYCLE PROCESS EMPLOYING INTEGRATED CRYOGENIC PURIFICATION

DATE-ISSUED: April 3, 1973

INVENTOR-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY |
|--------------------|-----------|-------|----------|---------|
| Pachaly; Robert W. | Greenwich | CT | | |

ASSIGNEE-INFORMATION:

| NAME | CITY | STATE | ZIP CODE | COUNTRY | TYPE | CODE |
|-------------------------------------|------------|-------|----------|---------|------|------|
| Gulf Research & Development Company | Pittsburgh | PA | | | 02 | |

APPL-NO: 05/ 135615 [PALM]

DATE FILED: April 20, 1971

INT-CL: [] F25j 1/00, F25j 3/00, F25j 3/02

US-CL-ISSUED: 62/39, 62/26, 62/20, 62/28, 62/40

US-CL-CURRENT: 62/613

FIELD-OF-SEARCH: 62/23, 62/24, 62/27, 62/28, 62/26, 62/29, 62/38, 62/39, 62/40, 62/54, 62/52, 62/53, 62/30, 62/40

PRIOR-ART-DISCLOSED:

U.S. PATENT DOCUMENTS

| PAT-NO | ISSUE-DATE | PATENTEE-NAME | US-CL |
|----------------|---------------|---------------|-------|
| <u>3678435</u> | July 1972 | Jackson | 62/28 |
| <u>3292381</u> | December 1966 | Bludworth | 62/27 |
| <u>2600110</u> | June 1952 | Hachmuth | 62/26 |
| <u>3348384</u> | October 1967 | Harmens | 62/38 |

ART-UNIT: 175

PRIMARY-EXAMINER: Yudkoff; Norman

ASSISTANT-EXAMINER: Purcell; Arthur F.

ATTY-AGENT-FIRM: Neishloss; Meyer Keith; Deane E. Ryder; Thomas G.

ABSTRACT:

A process and apparatus for the liquefaction of natural gas wherein raw feedstock is cryogenically fractionated to remove essentially all of the carbon dioxide and C._{sub.5}.sub.+ hydrocarbons therefrom, and wherein the cryogenically purified feedstock is cooled and liquefied under pressure in a cryogenic heat exchanger. The pressurized cold liquid from the heat exchanger is isenthalpically expanded to

reduce the pressure and further cool the liquid while at the same time flashing a minor gas fraction. Refrigeration for the liquefaction of the natural gas is supplied by a circulating refrigerant stream which is compressed and work-expanded to obtain the necessary cooling. The minor flash gas portion of the liquefaction step is commingled with the circulating refrigerant stream so that the analysis of the refrigerant stream is always rich in the lighter portions of the liquefaction stream, thus aiding in maintaining refrigeration temperature differentials to drive the liquefaction step. The work-expanded refrigerant portion undergoes a compression cycle and is work-expanded in a series of expansion turbines. The expansion turbines furnish at least part of the power necessary to drive the compressor system in the refrigerant gas cycle.

17 Claims, 1 Drawing figures

| Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments |
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| ISENTROPICALLY | 371 |
| ISENTROPICTY | 1 |
| ISENTROPICS | 3 |
| (17 AND ISENTROPIC\$4).USPT,PGPB,JPAB,EPAB,DWPI. | 23 |
| (L17 AND ISENTROPIC\$4).USPT,PGPB,JPAB,EPAB,DWPI. | 23 |

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